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SOUTHEASTERN MICHIGAN WASTEWATER MANAGEMENT SURVEY SCOPE STUDY.--ETC(U)
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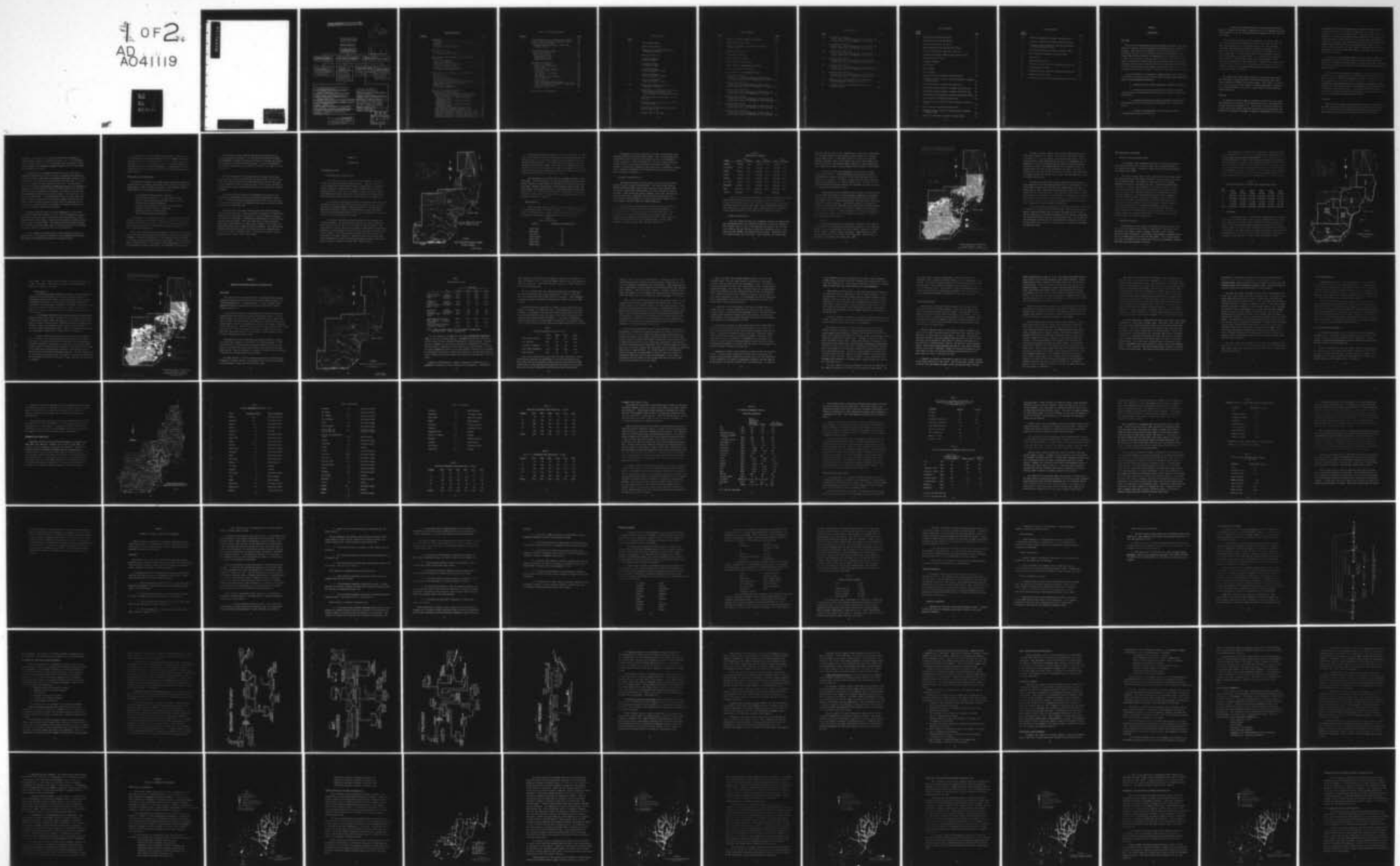

SOUTHEASTERN MICHIGAN
WASTEWATER MANAGEMENT
SURVEY SCOPE STUDY

REPORT COMPOSITION

SUMMARY REPORT
OVERVIEW OF STUDY

- **BACKGROUND APPENDIX** — BASE DATA INFORMATION
- **PLAN FORMULATION APPENDIX** — THE PROCESS OF PLANNING
  - **INSTITUTIONAL ARRANGEMENTS APPENDIX** — EXISTING AND PROPOSED WASTEWATER MANAGEMENT ORGANIZATIONS
  - **DESIGN AND COST APPENDIX** — TECHNICAL DESIGN AND ESTIMATED COSTS OF WASTEWATER MANAGEMENT COLLECTION AND TREATMENT SYSTEMS
    - LAND IRRIGATION AND COLLECTION FACILITIES (DOW ENGINEERING INC.)
    - LAGOON TREATMENT AND CONVEYANCE SYSTEMS (BAUER ENGINEERING, INC.)
    - ALTERNATIVES FOR STORMWATER RUNOFF CONTROL (AYRES, LEWIS, NORRIS AND MAY, INC.)
    - ADVANCED WASTEWATER TREATMENT FACILITIES (STANLEY CONSULTANTS)
    - INDEPENDENT PHYSICAL-CHEMICAL TREATMENT FACILITIES (IN CONSULTATION WITH WALTER J. WEBER Jr. Ph.D.)
    - GEOLOGIC CONSIDERATIONS (ANDREW J. MOZOLA, Ph.D.)
    - LAND TREATMENT OF WASTEWATER IN SOUTHEASTERN MICHIGAN (DEPT. OF CROP & SOIL SCIENCES, MSU)
    - WASTEWATER IRRIGATION USING PRIVATELY OWNED FARMLAND IN SOUTHEASTERN MICHIGAN (DOW ENGINEERING, INC.)
  - **EVALUATION APPENDIX** — IMPLICATIONS AND USE POTENTIAL OF PROPOSED WASTEWATER MANAGEMENT SYSTEMS
    - ECOLOGICAL ASSESSMENT FOR WASTEWATER MANAGEMENT SEM (INSTITUTE OF WATER RESEARCH, MSU)
    - HYGIENIC ASSESSMENTS (SCHOOL OF PUBLIC HEALTH, U OF M)
    - ECONOMIC (AREA) ASSESSMENT AND SOCIAL ASSESSMENT (MR. PAUL M. REID)
    - AGRICULTURAL ECONOMIC ASSESSMENT AND AN ANALYSIS OF ZONES PROPOSED FOR LAND TREATMENT OF WASTEWATER (MR. LEE A. CHRISTENSEN, ECONOMIC RESEARCH SERVICE, USDA.)
    - AESTHETIC ASSESSMENT (DETROIT DISTRICT STAFF)
  - **PUBLIC PARTICIPATION APPENDIX** — PROGRAM FOR PUBLIC INVOLVEMENT AND PARTICIPATION IN PLANNING PROCESS
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Chapter 1

INTRODUCTION

The Study

The aim of the Southeastern Michigan Wastewater Management Survey Scope Study is to develop long-range wastewater management plans for Southeastern Michigan. These plans would complement the water quality plans of the State of Michigan and thus assist in meeting the planning requirements of the Federal Water Pollution Control Act Amendments of 1972 (Public Law 92-500). To reach this aim the needs and objectives related to water pollution problems in Southeastern Michigan were defined, treatment systems and related components were designed, alternative plans were formulated, and the impacts of these alternative plans were assessed and evaluated based on technical, economical, institutional, aesthetic, ecological, and social considerations.

This study augments the wastewater treatment planning effort developed in the State of Michigan's plans entitled Plans for Water Quality Management, Phase II, for Southeastern Michigan by:

1. examining various advanced wastewater treatment technologies,

2. providing additional alternatives for control of critical combined storm and sanitary sewer overflows and other forms of urban stormwater runoff,

3. presenting alternative wastewater management systems which would approach the 1985 "no discharge of pollutants" goal in Public Law 92-500,

4. phasing the implementation of the alternative plans in accordance with Public Law 92-500, and

5. presenting alternative plans that would protect the surface waters of Southeastern Michigan, including Lake Erie, for swimming and other recreational uses, and for the protection and propagation of fish, shellfish and wildlife.

Four plans were selected as final alternatives for choice. They include three Representative Plans and one Interim Water Quality Plan. The three Representative Plans reflect application of the "best available technology" for wastewater treatment in Southeastern Michigan. They approach, as nearly as possible, the "no discharge of pollutants" goal of Public Law 92-500. The Interim Water Quality Plan was derived from the State of Michigan's water quality plan. It is identified as an interim plan because it could only hope to meet the 1983 requirement of "best practicable technology" in Public Law 92-500. Comparisons are made in the study between the Interim Plan and the Representative Plans to show the tradeoffs involved in selecting between alternatives designed to meet different water quality objectives.

The Survey Scope Study focuses primarily on water quality and wastewater management problems and does not specifically address other water resource needs and problems such as water supply, flood control, or recreation. The study does provide, however, wastewater management alternatives that complement potential solutions to these problems and make them more readily attainable.

Authority

The authority for this study is contained in sections from two public laws approved by the Congress of the United States and in two Congressional resolutions passed in November 1971. Section 206 of the Flood Control Act of 1965 (Public Law 89-289) authorizes the Secretary of the Army under the direction of the Chief of Engineers to prepare a comprehensive plan for the

development and efficient utilization of the water and related resources of the region drained by streams which discharge, within the State of Michigan, into the St. Clair River, Lake St. Clair, the Detroit River and Lake Erie. This plan was to meet the long range needs of the region for protection against floods, wise use of flood plain lands, improvement of navigation facilities, water supplies for industrial and municipal purposes, outdoor recreational facilities, the enhancement and control of water quality, related purposes, all with a view to encouraging and supporting the optimum long range economic development of the region and enhancing the welfare of its people.

Section 102 of the River and Harbor Act of 1966 (Public Law 89-789) authorizes the study of the Great Lakes, particularly Lake Ontario and Lake Erie, in connection with water supply, pollution abatement, navigation, flood control hydroelectric power and other related water resources development and control.

The House of Representatives on November 10, 1971, and the Senate on November 23, 1971, passed similar resolutions which gave the Corps of Engineers specific authority to undertake a survey scope study for wastewater management in the Southeastern Michigan area. In carrying out the investigation, alternatives were to be evaluated for management of wastewater on a regional basis and were to be developed with the participation, consultation, cooperation of the U.S. Environmental Protection Agency, State and local water pollution control agencies, and State and local agencies with environmental planning responsibilities.

Background

Water quality management has undergone many changes in recent years. The basic purpose was the elimination of public health hazards prior to 1950. Growing concerns with broader environmental problems and recent Federal and state legislation have changed the focus to multiple

objectives. In 1970 many of the Federal environmental programs were brought together under one administrative agency, the U.S. Environmental Protection Agency (USEPA). In 1971 the USEPA issued guidelines for water quality planning that emphasized regional programs on both a river basin and metropolitan area basis.

In recognition of the changing national priorities, the Corps of Engineers received approval from the Office of Management and Budget and from the Congress to undertake pilot wastewater management studies for five urban areas. One of these was the Southeastern Michigan area. The first step was a feasibility study completed in July 1971. The objectives of this report, entitled Alternatives for Managing Wastewater for Southeastern Michigan, were to identify the present and future water quality problems and to evaluate the feasibility and impacts of alternative regional wastewater management systems to solve these problems. The conclusions of the feasibility study were: the problems were regional in nature; there were several feasible alternatives to solve these problems; and more detailed study of these problems and their solutions should be undertaken as soon as possible. As noted earlier, in November 1971 Congress authorized the Corps to proceed with these detailed studies.

The Federal Water Pollution Control Act Amendments of 1972 (Public Law 92-500) became law on October 18, 1972. This law established national water quality policies, goals, and objectives and reinforced the primary responsibility of the states in planning and implementing wastewater management and water resource systems. Even though this study was well underway at the time this law was passed, many of the provisions in the law had been anticipated and were incorporated into the study objectives.

The U.S. Canadian Great Lakes Water Quality agreement was signed on April 15, 1972. The objectives contained in this agreement had also been anticipated and influenced the selection of study objectives.

The wastewater study for Southeastern Michigan is actually part of the Southeastern Michigan Water Resources Study, a broader total water resources study being carried out by the U. S. Army Corps of Engineers under Section 206 of P.L. 89-789. The final wastewater management plan selected by the state and local governments for implementation will be incorporated into the total water resources planning being done under this overall study.

Participation and Coordination

Throughout the conduct of the study, members of various governmental agencies and public interest groups were involved and participated in the study through a study coordinating committee. The committee included representatives of the following agencies and groups:

Environmental Protection Agency - Region V
Soil Conservation Service, U. S. Dept. of Agriculture
Bureau of Sport Fisheries and Wildlife, Dept. of Interior
Michigan Water Resources Commission
Institute of Water Research, Michigan State University
Southeast Michigan Council of Governments
Metropolitan League of Women Voters
Detroit Metropolitan Water Department

The objectives of the committee were:(1) to provide input during development of prospective alternative plans, (2) to serve as a forum for varying technical and public views to insure full cooperation, and (3) to provide insight and review on alternative proposals as spokesmen for their respective organizations.

The State of Michigan concurrently conducted a regional study for much of the same Southeastern Michigan area based on a lower level of wastewater treatment. This study provided most of the information used to develop the Interim Alternative presented later in this report. The State and the Corps coordinated fully, in this respect, eliminating duplication of effort while providing information pertinent to the development of each study.

The Institute of Water Research, Michigan State University, was the prime ecological evaluator. Its staff provided guidance throughout the development of technical systems with regard to favorable and unfavorable impacts of alternative technical choices. They also evaluated the various plans and provided a description of impacts on the region for each alternative.

The Soil Conservation Service provided large amounts of soil data required in the evaluation and selection of lands suitable for land irrigation. They have also served as liaison between the Corps and the people in these respective areas with whom they deal in their normal activities to encourage them to take a more objective look at land irrigation of treated wastewater.

The Southeast Michigan Council of Governments was involved in the development of population projections and projected expansion of service areas. It provided information regarding current plans for the study area in the field of water supply and wastewater facilities for help in defining existing and proposed facilities.

The general public and other interest groups were involved through a series of public meetings, informal workshops, and seminars or presentations conducted during the course of the study. A public information brocnure, "The Search for Clean Water," presenting the developments of the first stage of study, was distributed. These tools were used to inform interested people about study progress, to solicit their reaction to any and all proposed alternatives, and to gather pertinent information. The reactions and information obtained were used to help form the initial alternatives and to help in the later screening process. The public involvement program is discussed in more detail later in this report.

Chapter 2

THE STUDY AREA

The Study Area Today

The Southeastern Michigan Region

The study area of this report, as shown in Figure 1, includes all or part of eight Southeastern Michigan counties. They are: all of St. Clair, Macomb, Wayne and Washtenaw Counties; approximately 75 percent of Oakland, Lenawee, and Monroe Counties, and approximately 30 percent of Livingston County. This area is a mixture of highly urbanized, suburban and outlying agricultural areas with a total popluation of approximately four-and-one-half million people and a total area of 4,900 square miles.

The climate in Southeastern Michigan is moderated by the stabilizing influence of the Great Lakes prevailing westerly winds passing over Lake Michigan which subdue extremes in weather conditions. The mean annual temperature compiled at Detroit is approximately 49 degrees Fahrenheit. The mean monthly temperature ranges from a high of approximately 73 degrees in July to a low of 25 degress in January.

In general, the annual precipitation does not vary greatly over Southeast Michigan. The average annual precipitation over the study area varies from 28 inches at Mt. Clemens to about 34 inches at Adrian. The precipitation is usually ample for the growth and development of vegetation, averaging 31 inches annually over the area with less than 25 percent of the total as runoff. Total annual snowfall averages vary from 42 inches at Port Huron to 29 inches at Monroe. Long term records for this area show that precipitation is evenly distributed throughout the year, varying from about 2 inches in January to slightly over 3 inches in June.

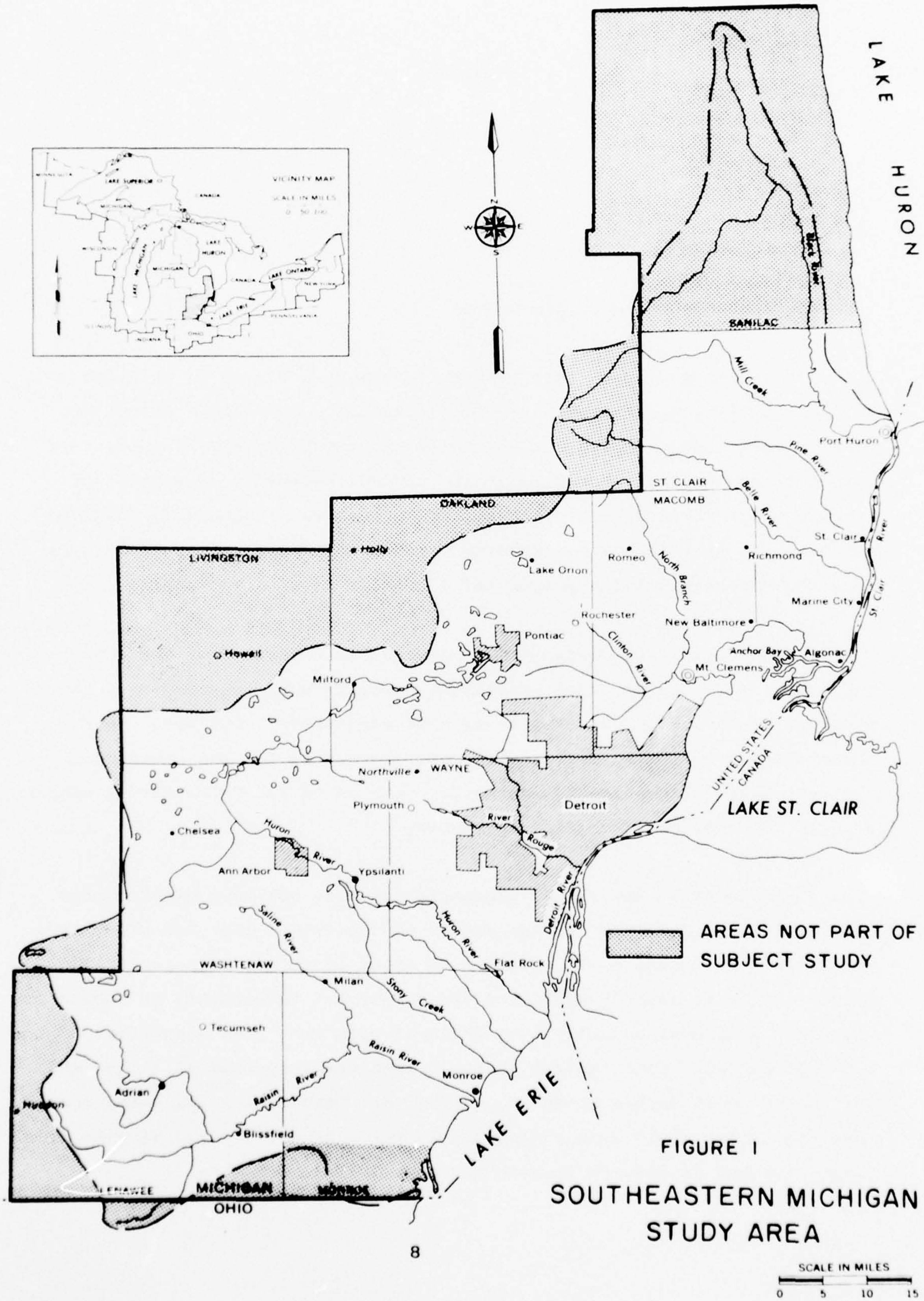


FIGURE 1

SOUTHEASTERN MICHIGAN STUDY AREA

Southeastern Michigan is subject to two types of storms. The first type is the large area storm of long duration and moderate intensity and the other type is the short term, thunder storm type rainfall of short duration and high intensity. The longer duration storms occur any time throughout the year, but intense local storms of the thunderstorm type usually occur in the late spring and throughout the summer. Local records indicate that major storms which produce high runoff over large areas have been limited to a duration of three days or less.

The topography of the study area can be divided into two distinct land forms. In the western half, or upstream portions of the major tributaries, rolling to rugged terrain is interspersed locally with relatively flat areas. Numerous inland lakes, interconnected by marshy lands, and small streams, are found in the area. In the eastern half or lower lake bed portion of the study area, the terrain is predominantly level without any natural-formed lakes. From the lake shore inland the elevation rises gradually from 600 to 1,000 feet.

Water Resources

Seven principal streams traverse the Southeast Michigan area. Data on their drainage areas is presented in Table 1. It should be noted that part of the drainage areas of some of these streams lies outside the boundaries of the wastewater management survey scope study area.

Table 1

RIVER DRAINAGE AREAS

Stream	Drainage Area (Square Miles)
Black River	746
Belle River	232
Pine River	199
Clinton River	767
Rouge River	455
Huron River	923
Raisin River	1,043

An abundance of natural and artificial lakes constitute one of the Southeast Michigan Area's major natural assets. Most of the natural lakes are located in the moraine hills and outwash region in the northwestern portion of the area. There are a total of 3,681 lakes, with a total lake acreage of 51,005 acres, and 954.4 miles of inland lake shoreline. In addition, the waters and shoreline of the Great Lakes and connecting channels provide additional resources to the Southeast Michigan area with approximately 300 miles of shoreline.

Demographic Characteristics

Southeastern Michigan, like the nation, has experienced expanding urbanization over the past several decades. The three central counties--Macomb, Oakland and Wayne--have served as the hub of this outward growth. Sub-centers of population growth encircle the city of Detroit at varying distances. These include the cities of Monroe on the south; Ann Arbor and Ypsilanti on the west; Southfield, Royal Oak, Troy and Pontiac to the north; Warren, Sterling Heights, St. Clair Shores and Mt. Clemens to the near northeast, and Port Huron still farther northeast.

The population of Southeastern Michigan increased 1,411,000 from 1950 to 1970, and accounted for 56 percent of Michigan's growth of 2,503,000. Due to a decline in the birth rate after 1960 and to some reduction in the rate of economic growth, the population gain of the southeastern area dropped to about 560,000 from 1960 to 1970, compared to 851,000 the previous decade. The population figures, obtained from Department of Commerce Census data, are shown in Table 2.

Table 2

POPULATION BY COUNTIES

County	1950 Pop.	1950 % Total	1960 Pop.	1960 % Total	1970 Pop.	1970 % Total
Lenawee	64,629	1.9	77,789	1.8	81,951	1.7
Livingston	26,725	0.8	38,233	0.9	58,967	1.2
Macomb	184,961	5.4	405,804	9.5	625,309	13.0
Monroe	75,666	2.3	101,120	2.4	118,479	2.4
Oakland	396,001	11.6	690,259	16.2	907,871	18.9
St. Clair	91,599	2.7	107,201	2.5	120,175	2.5
Washtenaw	134,606	3.9	172,440	4.1	234,103	4.8
Wayne	2,435,235	71.4	2,666,297	62.6	2,669,604	55.5
Totals	3,409,422		4,259,143		4,816,459	

Due to the trend of decentralization of economic enterprises, primarily manufacturing, retail and service activities, the City of Detroit has decreased in population since 1950. The rest of Wayne County as well as the adjoining counties of Macomb and Oakland, achieved significant population gains during the two decades since 1950. Only Washtenaw of the outlying counties has experienced similar high rates of population increase.

Economic Characteristics

The core economic activity of Southeastern Michigan for some decades has been manufacturing, with automotive production as the major component. This industry, which is basic to the manufacturing complex, had its inception in Detroit and has continued to maintain an important portion of its fabricating and assembly operations within the region. Automotive plants are scattered widely over the region. Other industries are located both

along the shoreline and inland. Secondary metal fabricators, food processing, and power plants are concentrated in the northeast (St. Clair and Clinton River basins); primary metal production, chemicals and allied products, and power plants, are located in the central area (Detroit and Rouge River basins); and secondary metal fabricators, paper products and power plants are situated in the southwest (Huron and Raisin River basins).

From 1950 to 1970, total employment increased 471,933--from 1,343,172 to 1,815,105. Although manufacturing employment registered a small numerical increase, this sector of the economy declined from 45.8 percent to 36.8 percent of the total. During this same period, non-manufacturing has experienced a significant upward trend. From 1954 to 1967, while manufacturing employment grew 64,108, employment in retail, wholesale and selected services mounted 131,430.

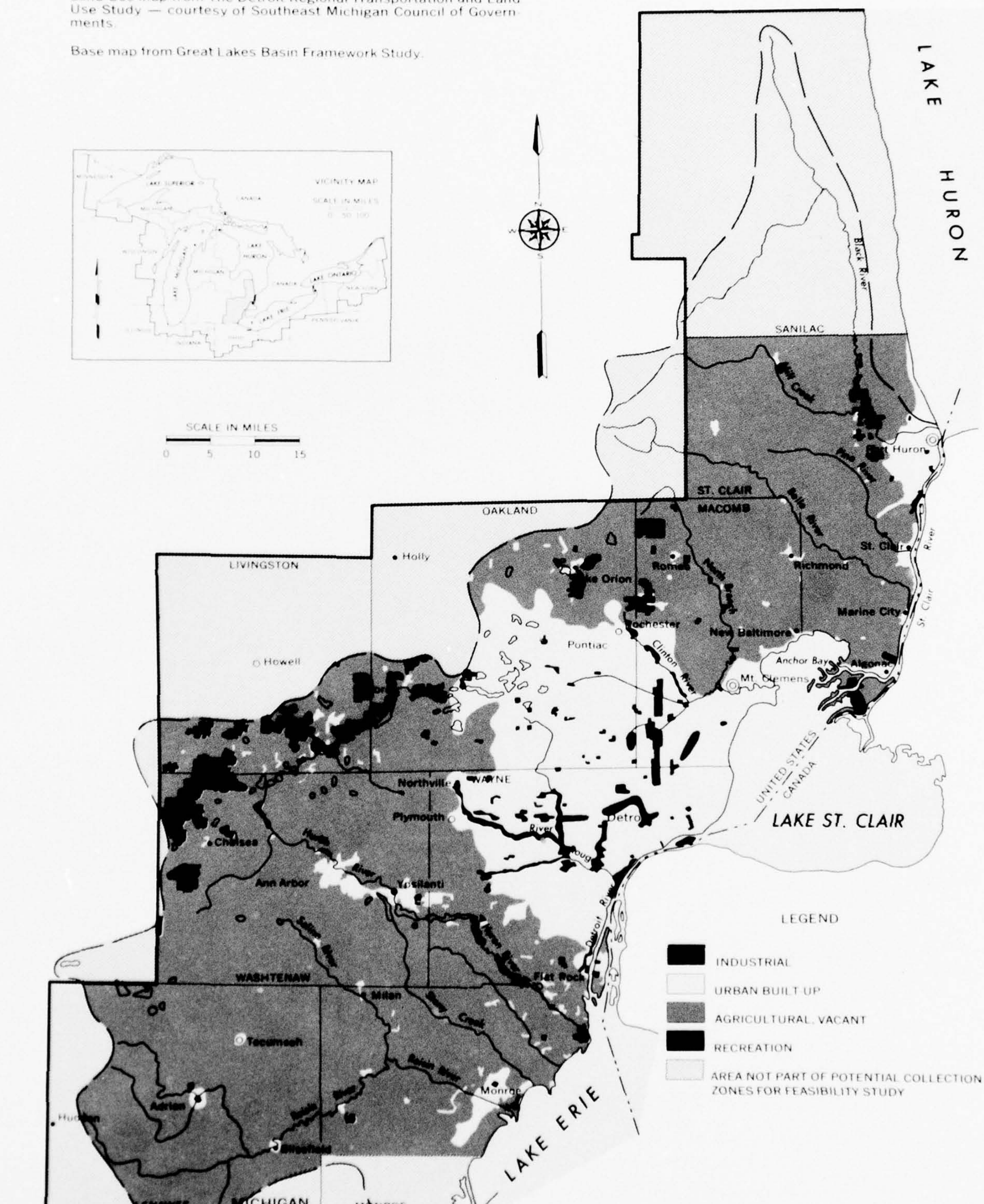
Urbanization has been spreading from the central city--Detroit--and from the other urban centers to the surrounding communities and townships. One feature of this movement has been the dispersed pattern of economic establishments, such as, manufacturing plants, shopping centers, office and professional service complexes. The largest portion of this spread of economic activity has been confined to the three central counties of Wayne, Oakland and Macomb which comprise the Detroit Standard the Metropolitan Statistical Area (SMSA). In 1950, employment in the Detroit Metropolitan area constituted 88.8 percent of the total of nine counties. By 1970, it still accounted for 82.3 percent.

Land Use

Southeastern Michigan is significantly influenced by the character and activities of the metropolitan areas which form parts of this important region. As previously mentioned, the Detroit SMSA is composed of the three central counties of Wayne, Oakland, and Macomb. Washtenaw County, with Ann Arbor as its major city, forms the Ann Arbor SMSA. Monroe County, to the south, is included in the Toledo, Ohio, SMSA.

Land Use Patterns for St. Clair, Macomb, Oakland, Wayne, Washtenaw and Monroe Counties adapted from a generalized 1965 Land Use Map from The Detroit Regional Transportation and Land Use Study — courtesy of Southeast Michigan Council of Governments.

Base map from Great Lakes Basin Framework Study.



Wastewater Management Feasibility Study
Southeast Michigan — Lake Erie
GENERALIZED LAND USE PATTERN — 1965

U.S. Army Corps of Engineers, Detroit District

The map in Figure 2 depicts the 1965 major land uses within the seven major counties of the region. This land use pattern was surveyed and mapped for the Detroit Regional Transportation and Land Use Study, a special project of the Southeast Michigan Council of Governments and its predecessor, the Detroit Metropolitan Area Regional Planning Commission. Industrial corridors, the highway network, major residential areas and regional parks are shown for the predominant land uses. Since 1950, the successive incorporation of over 20 cities and villages, from former township lands that were considered farm or rural, has highlighted the process of spreading urbanization.

As might be expected from increased urbanization, the farm and rural populations have experienced marked declines in their numbers. The latest census figures (1970) show that only Monroe County with some 53 percent and St. Clair County with 48 percent rural populations still have significant rural characteristics. This reduction in the number of farms and farm population reflects the consolidation of farming units, decreasing farm family size and changes in farm operations. Even though the value of farm products produced in the Southeast Michigan region has continued to rise, the percent of land in farms has diminished.

Major crops grown in the area are corn, grain, soybeans, and alfalfa. In addition to cropland, the Southeast Michigan river basins have approximately 17 percent of their land in forests, estimated at 665,700 acres. Oakland County has the greatest concentration with 28 percent, while Monroe and Wayne Counties have the least with ten percent each. As the need for more recreation land and land for urban expansion increases, forest land for wood products will give way to multiple use for recreation, aesthetics and municipal parks.

The Study Area in the Future

Factors Influencing Future Growth

It is expected that Southeastern Michigan will sustain its economic and population growth over the next 20 years, but at lower rates than in the previous two decades. A number of significant factors are anticipated to influence such growth.

The region's ample supply of high quality water will not only sustain the growing population and economic activities, but will serve as an incentive to further growth. The maturing of the area as one of the major metropolitan regions of the nation will mean a further drive toward self-sufficiency, and hence some broadening of the range of economic activity. This will mean greater employment in the service, professional, and technical occupations and a smaller proportion of total employment in manufacturing enterprises. The current population base will be augmented mainly by natural increase, with little in-migration from other parts of the nation. Increases in population will call for greater amounts of goods and services and hence stimulate the economy. National demand for the distinctive products of Southeastern Michigan is expected to continue and grow; hence, the production of motor vehicles, fabricated metals, chemicals, and pharmaceuticals will be increased. The continued decentralization of economic activity with its associated spread of residential areas will increase urbanization.

Population Projection

The population of the region is projected to continue to grow, but at a slower rate than for the previous 20 year period. The basis of the growth will be primarily natural increase, with only a small portion developing from in-migration. The economy is anticipated to continue active, but not as expansive as in the previous two decades. With a larger population base, the demands for both goods and services will undoubtedly increase, thus spurring further economic activities.

The population projections for the study area, presented in Table 3, were developed from activities of the Southeastern Michigan Water Resources Study--Economic Workshop Subcommittee. Basic census data for 1970 from the Department of Commerce Basic data were supplied by the Southeast Michigan Council of Governments with projection methods and results developed by the Corps of Engineers. These projections were developed according to five subareas which were formed to facilitate ease of data collection and development of necessary projections. This subdivision was influenced by the existing wastewater collection systems, demographic and economic growth patterns, and institutional considerations and is shown in Figure 3.

Table 3

POPULATION PROJECTION BY SUBAREA, FOR SOUTHEASTERN MICHIGAN

Sub Area	1970	1980	1990	2000	2010	2020
1	112,000	123,000	148,000	168,000	192,000	219,000
2	3,049,000	3,388,000	3,783,000	4,181,000	4,643,000	5,163,000
3	1,097,000	1,303,000	1,556,000	1,819,000	2,130,000	2,410,000
4	265,000	362,000	444,000	539,000	645,000	758,000
5	164,000	181,000	199,000	226,000	253,000	281,000
Total	4,687,000	5,357,000	6,130,000	6,933,000	7,863,000	8,831,000

The Economy

Total employment for the Southeastern Michigan region is projected to rise to 2,437,300 in 1990, a gain of almost 623,000 or 26 percent over 1970. There was a 34 percent gain in the previous 20-year period from 1950 to 1970. Though manufacturing employment is expected to rise some 35,000 by 1990, its share of total employment will decline from 37 percent to 29 percent. The largest gains are projected in service and professional employment where an increase of over 305,000 is expected. Retail trade employment is anticipated to increase 71,000 and wholesale trades

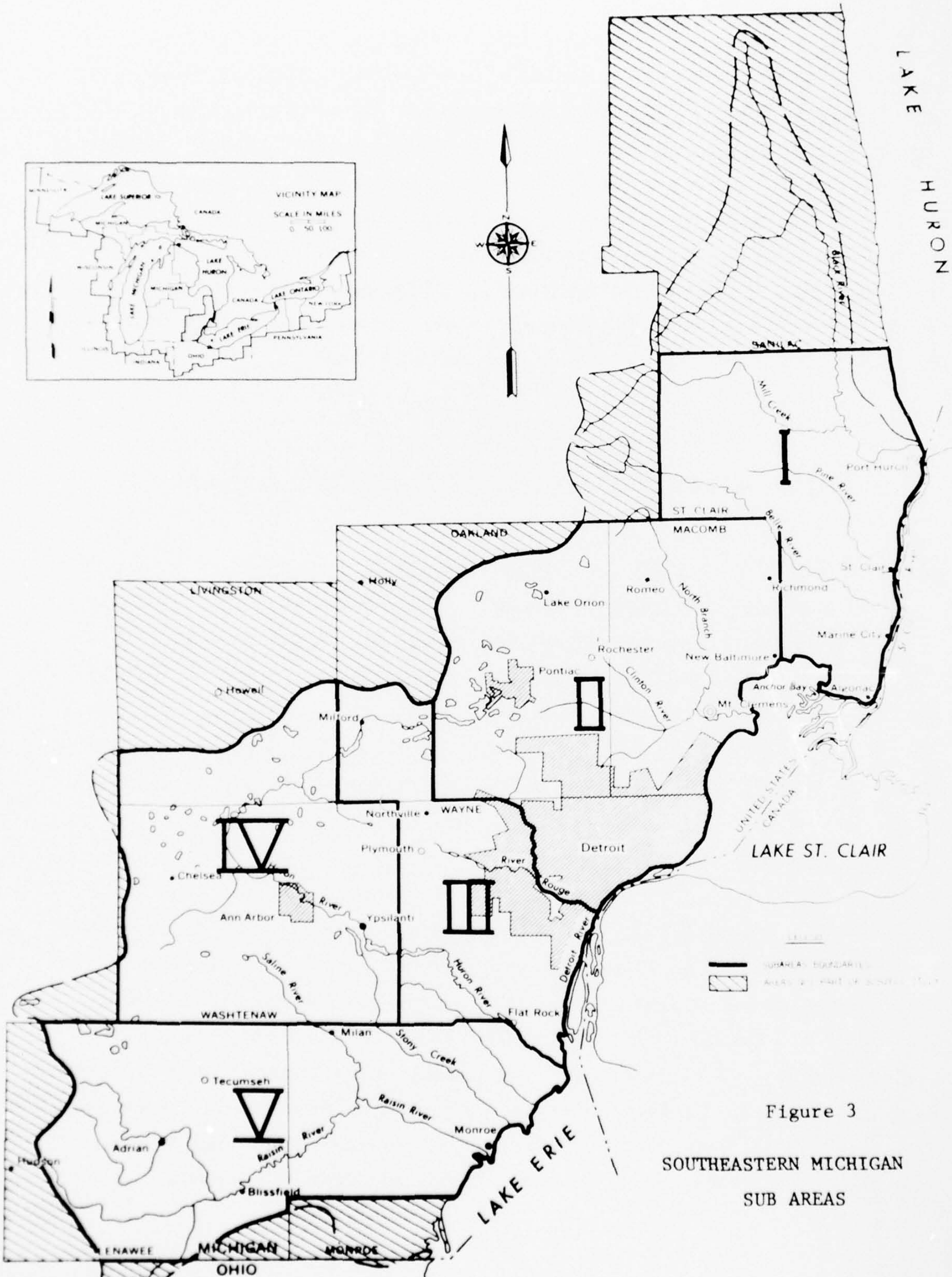


Figure 3

SOUTHEASTERN MICHIGAN
SUB AREAS

over 16,000. Public administration employment is projected to rise some 65,700. Employment in agriculture, forestry and fishing industries are expected to continue to decline.

Future Land Use

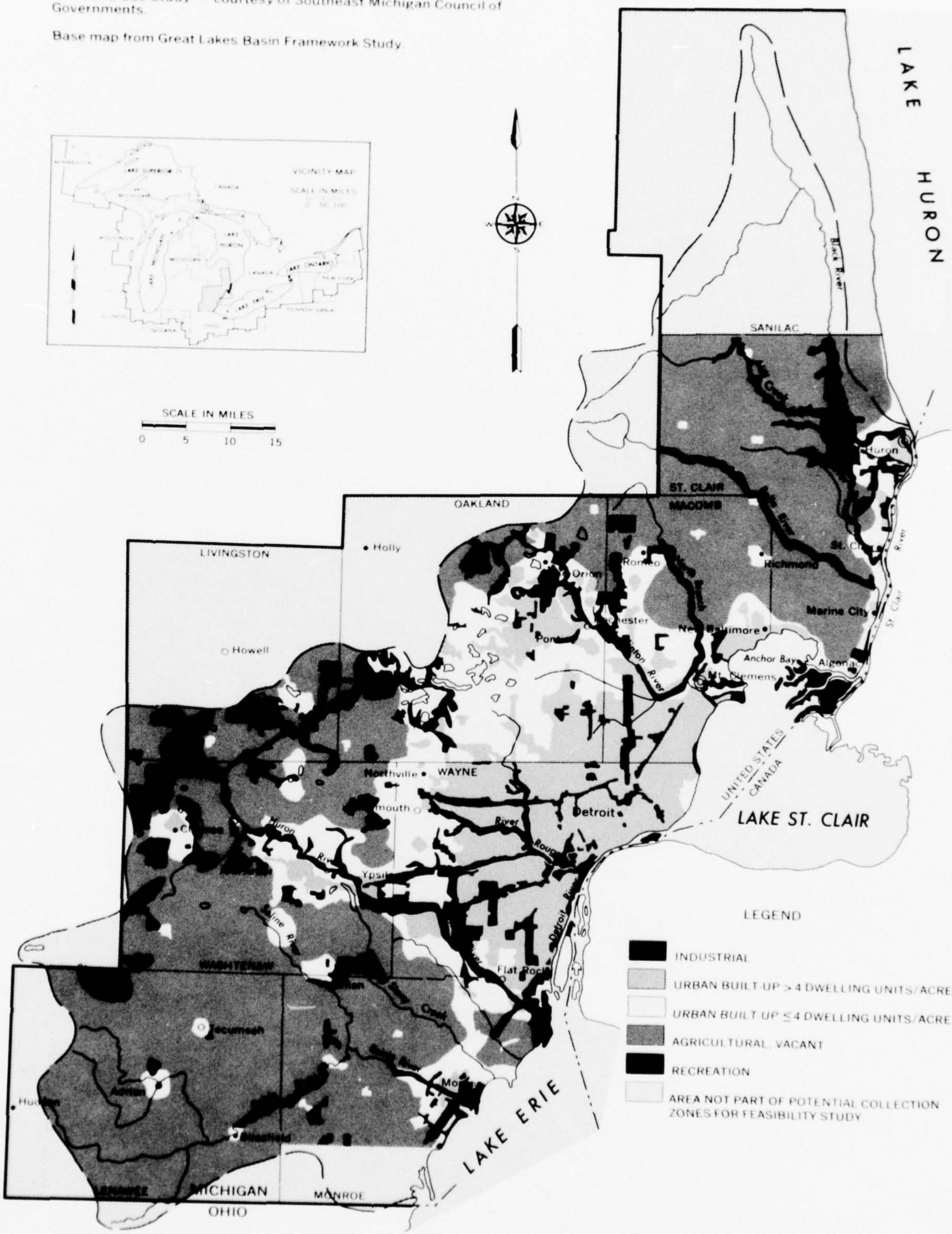
The generalized future land growth patterns for the Southeastern Michigan area were developed by the Southeast Michigan Council of Governments special project TALUS. A map showing this land use pattern is presented in Figure 4. This land use plan projects a continuing "beefing up" of the industrial corridors of the region, an increase in the spread of residential development around the economic centers, larger regionals recreational areas, and a significant decrease in agricultural and vacant land.

It is expected that Detroit will remain the major population and economic center of the region. Beyond this city's borders, considerable population and economic growth are expected in such cities as Warren and Sterling Heights in Macomb County; Southfield and Troy in Oakland County; Dearborn, Livonia, and Westland in Wayne County, and the Ann Arbor-Ypsilanti complex in Washtenaw County, as well as the Monroe City and Port Huron complexes in Monroe and St. Clair Counties, respectively.

Regional recreational and open space developments are planned for 1990 in connection with the major waterways and bodies of water within the region. At a more refined scale, county and municipal development of recreation resources by utilization of flood plains of the Black, Huron, Clinton, Raisin, and Rouge Rivers is expected. Use is expected to be made of the open space and recreational potentials in the morainal areas of western portions of Oakland and Washtenaw Counties. The shore lines of the St. Clair River, the Detroit River, and Lake Erie offer further potentials for recreational facilities at the local, county, regional, and state scale of operation.

Land Use Patterns for St. Clair, Macomb, Oakland, Wayne, Washtenaw and Monroe Counties adapted from 8 August 1969 Comprehensive 1990 Plan Map from The Detroit Regional Transportation and Land Use Study — courtesy of Southeast Michigan Council of Governments.

Base map from Great Lakes Basin Framework Study.



Wastewater Management Feasibility Study
Southeast Michigan — Lake Erie
GENERALIZED LAND USE PATTERN — PROJECTED, 1990

U.S. Army Corps of Engineers, Detroit District

Chapter 3

WATER RESOURCE NEEDS, PROBLEMS AND OPPORTUNITIES

Water Uses

The Great Lakes Basin Commission (GLBC) established fifteen planning subareas throughout the Great Lakes to study water resources needs, problems and opportunities. Planning subarea 4.1 covers the eight county Southeastern Michigan Study area and includes a ninth county, Sanilac County (See Figure 5).

In 1970 about 87 percent of the population in this nine county area obtained their water through 240 central distribution systems. Of these water systems, 93 obtain their water from Lake Huron, the St. Clair River, Lake St. Clair, the Detroit River, and Lake Erie; 7 draw water from inland surface waters; 138 rely on ground water; and 2 use both inland streams and ground water sources. Municipal use exceeded 650 million gallons per day (MGD) in the mid 60's. While 90 percent of the water is taken from the Great Lakes and connecting channels, only 50 percent is used by people located in basins draining directly into them.

The population served by municipal water supply systems in 1970 was 4.4 million and is expected to increase to 8.9 million by 2020. In 1970, about 91 percent of the population used water withdrawn from Great Lakes sources, 3 percent from inland surface waters, and 6 percent from ground water sources. These percentages are expected to change to about 97 percent, 1 percent, and 2 percent respectively, by 2020.

As shown in Table 4, the 1970 average daily municipal withdrawal was estimated to be about 739 MGD. The projected figure for 2020 is 1700 MGD, a total increase of almost one billion gallons daily.

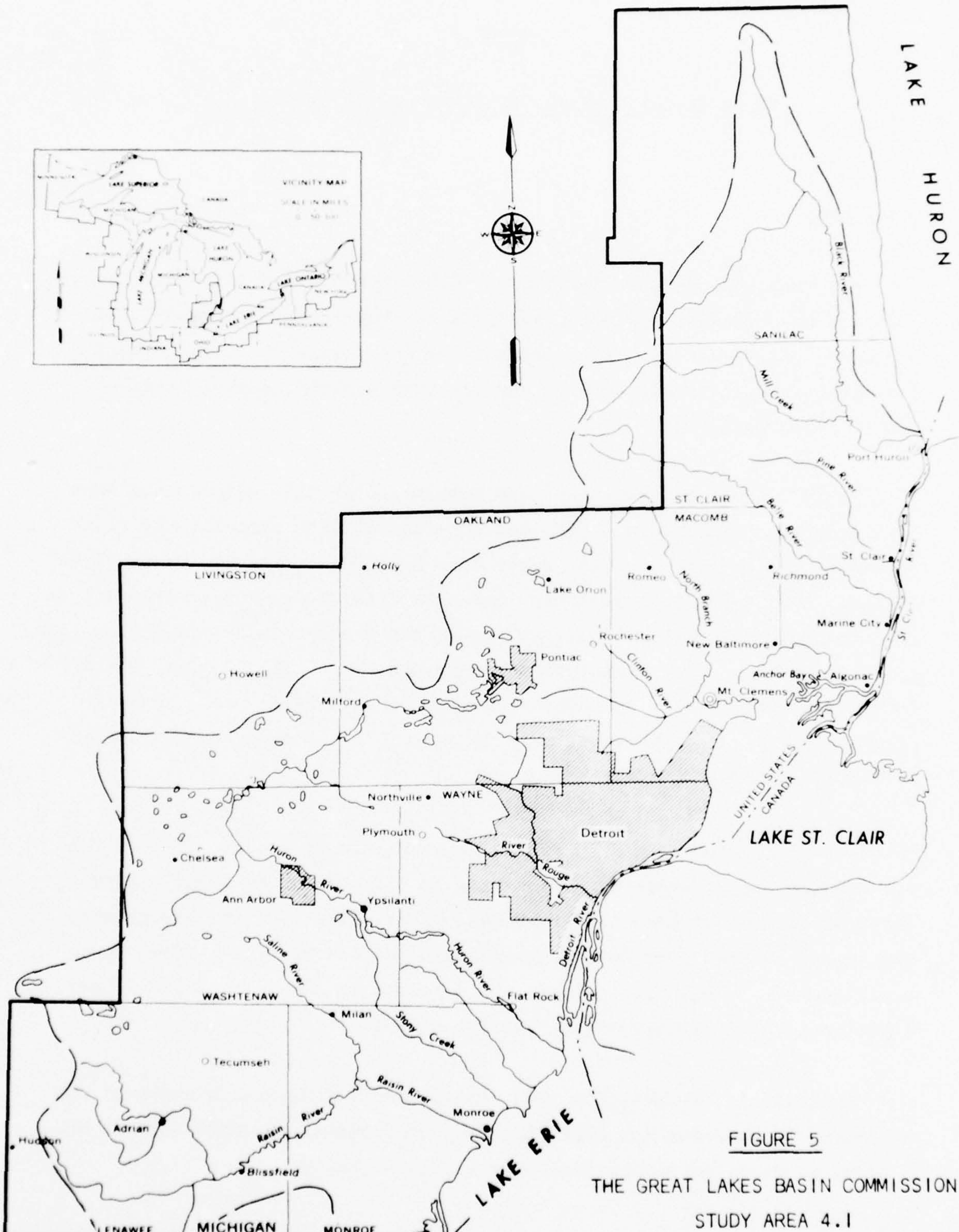


FIGURE 5

THE GREAT LAKES BASIN COMMISSION
STUDY AREA 4.1

Table 4

MUNICIPAL WATER USE*

	YEAR	FLOW MGD 1970	1980	2000	2020
Total Municipal Water Supply (mgd)	Demand	738.9	890	1,240	1,700
	Consumption	60.8	80	140	200
	Discharge	678.1	810	1,100	1,500
Domestic and Commercial, Municipal Water Supply (mgd)	Demand	474.4	570	790	1,100
	Consumption	47.5	60	80	100
	Discharge	426.9	510	710	1,000
Municipally Supplied Industrial Water (mgd)	Demand	264.5	320	440	610
	Consumption	13.3	20	60	100
	Discharge	251.2	300	380	510
Total Municipal Discharge		678.1	810	1,100	1,500
Total Domestic - Commercial Discharge		426.9	510	710	1,000
Total Municipally Supplied Industrial Discharge		251.2	300	380	510

*From: Municipal Water Supply for Southeastern Michigan Water Resources Study. Draft 1 January 1971

The City of Detroit, through the Detroit Metropolitan Water Department (DMWD) is the major regional supplier. The DMWD pumped 207 billion gallons from the Detroit River in 1966 and served about 3.5 million people. Presently Detroit is engaged in a $110 million construction program which includes a 1200 MGD intake in Lake Huron and new facilities to treat 400 MGD. It's probable that a substantial portion of the new treatment facilities will be devoted to replacement of obsolete or inefficient facilities. The new intake capacity should satisfy projected water supply needs beyond the planning period for this study.

Depletion ("consumption") of water in domestic and commercial use is estimated to continue to be about 10 percent of withdrawals. Consumption of

water supplied by municipalities to industry is assumed to take place at the rates calculated by the U.S. Bureau of Domestic Commerce for "other manufacturing" for a given year. This rate rises from 5 percent in 1970 to 16 percent in 2020 for the study area.

The use of inland lakes and streams and ground water in Southeastern Michigan for municipal water supply is expected to decrease as more and more cities switch sources and draw from the Great Lakes. Total withdrawals from these sources are expected to decrease from 64 MGD in 1970 to 44 MGD in 2020.

Manufacturing water withdrawals at present are about double the withdrawals for domestic and commercial uses. Total withdrawals for all manufacturing are estimated to have been 1.56 billion gallons per day in 1970, of which about 265 MGD or about 17 percent of the total was obtained from municipal water supply systems (see Table 5). This ratio of municipally supplied industrial water is quite high in comparison to the national ratio of less than 10 percent, and the overall Great Lakes Basin ratio of 11 percent.

Table 5

ESTIMATED INDUSTRIAL WATER USE (MGD)

	1970	1980	2000	2020
Gross Water Required	2633	3672	9166	16618
Self Supplied	1297	900	589	1092
Municipally Supplied	265	319	442	612
Total Water Withdrawal	1562	1219	1031	1704
Water Consumed	148	196	430	994

There are two factors which may account for these differences. First, manufacturing industries are predominant in the area and although large water users such as the automotive industry receive their water from other sources, most of these manufacturing industries have smaller water requirements that are most economically satisfied by purchase from municipal

systems. Second, there is a limited amount of frontage on Lake St. Clair and the Detroit River available for concentrations of industries and also a lack of sizeable inland surface sources available. These conditions prevent a large number of these industries from developing their own individual water supplies. These factors will continue to influence industrial water supply development and it is expected that municipal water systems will provide even larger shares of the industrial water requirement of the future.

Lake St. Clair and the Detroit River are the principal sources of self-supplied industrial water in the Detroit metropolitan area. Lake Erie is a major source in the southeast counties, and Lake Huron and the St. Clair River are the major sources in the northeast. Surface streams such as the Raisin, Huron, and Rouge Rivers are also used for industrial supplies, but there is no information available about the quantities obtained from any of the sources. Information is not available on well water supplies used by industries, but because of the relatively poor yields of ground water aquifers, it is believed that industry-operated wells provided only a very small part of the total industrial water used.

For the total manufacturing sector, output measured in value added by manufacture is projected to increase from about $10 billion in 1970 to $60 billion in 2020. If it is assumed that existing manufacturing plants can enlarge their capacities at present locations by 100 percent and that will, in turn, double the present value added by manufacture, then some $40 billion of manufacturing activity will be occurring at new plants in new locations for which new supplies must be developed. Much of the new industrial development will occur in the counties that are inland from the lakeshore if sufficient water supply is made available. The inland dispersal of new industries could be achieved by the development of regional, municipal systems to provide the industrial water through the development of local sources in conjunction with the transfer of large quantities from Lake Huron, Lake Erie, and the connecting river-lake system.

Table 5 presents the estimated industrial water use for 1970 and projected years. The gross water required, self-supplied, municipally supplied, and total water withdrawal requirement is shown. The water use estimates represent the needs of all establishments without differentiating between small water users and large. The large water using establishments (those that withdraw 20 million gallons per year or more) are relatively few in number and probably do not exceed 300 factories, but the impact of their water requirements is huge. It is estimated that the 300 large water using establishments account for more than 97 percent of the total withdrawal needs of the manufacturing sector.

In addition to the concentration of the water use among these 300 plants, there is a further concentration of water use within particular industry groups. The largest water withdrawals are from the Primary Metals Industry Group followed by Chemical and Allied Products. Manufacturing establishments in these two groups accounted for 1149 mgd of the estimated total manufacturing withdrawals of 1562 mgd.

Recirculation and reuse of water within their plants enabled manufacturers to meet their larger gross water requirement of 2633 mgd in 1970. The recirculation rates in the two largest water withdrawal groups are the lowest. For these two industry groups in particular, reasonable improvements in recirculation rates can bring about dramatic reductions in the quantities of water to be supplied. Improvements in recirculation are forecast to occur with the net results showing a slight decrease in total manufacturing withdrawals to the year 2000 after which the withdrawals will increase to about 1700 mgd by the year 2020.

Consumption of water is also expected to increase during the projected period. In manufacturing, consumption includes water incorporated into products, and unaccounted losses such as leaks, but by far the largest part of the consumption is a result of evaporation induced by the heat taken up by the water in its uses as a coolant and as a process water. In addition

to the consumption of water by manufacturers, water is also consumed by thermal power generating plants and irrigated agriculture through evaporation and transportation. The combined consumption will result in increased vapor and associated heat energy emissions into the atmosphere.

Other water uses in the area are less significant than the municipal and industrial uses just discussed in terms of total withdrawal. In 1970 the development of rural water supply systems provided 49 mgd for rural, domestic, livestock, spray water, and non-farm uses in the GLBC southeast Michigan area. The irrigation water requirement for production of high value crops including potatoes, fruits, vegetables, and sod was 37.4 mgd in 1970 and for irrigation of golf courses was 12.6 mgd. Inland lakes and streams and ground water are the primary sources of rural supply and irrigation water.

A seasonal average of 41 mgd was required for primary mineral production in 1968. The major water sources for the mineral industry in the GLBC southeastern Michigan area are inland lakes and groundwater.

The recreational uses of the water resources in the area include fishing, boating, and swimming. Numerous inland lakes in the rolling wooded morainic hills provide the backdrop for recreational activity. The rivers offer additional opportunity for obtaining land for recreational areas, especially the Huron and Clinton Rivers. Frontage on Lake Erie, Lake St. Clair, the Detroit River, and St. Clair River provides a potentially valuable asset to the resource base, although there are inherent problems which restrict full use of these resources. Industrial and residential development, often blighted, precludes public recreation in urban areas where the need is generally greatest. Pollution of these waters by the wastes from residential and industrial complexes has also seriously restricted the use of much of these resources. Mercury in Lake St. Clair, according to the Michigan Health Department, threatens health, causes economic loss and hinders fishing pleasure.

The Great Lakes and connecting channels in the area are important to the commercial navigation activities of the entire Great Lakes Region. The

inter-lake traffic shipping is dependent on the depths that can be obtained in these connecting waterways, namely the St. Clair-Detroit River systems. The extensive frontage along this system provides port facilities for more than 50 ship lines and accounted for 31 million tons of cargo in 1970 at Detroit alone. The solution to these non-withdrawal water needs and problems, although not specifically addressed, will be complemented by the wastewater management alternatives and make them more readily attain-
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Surface Water Quality

Water quality investigations were conducted by the Public Health Service, the Institute of Water Research, state and local agencies, and others on the major surface waters of the area. The condition of these waters are reflective of the areas they drain or flow through. There are four main sources of pollution from the urbanized areas: stormwater outlets, combined sewer overflows, industrial outfalls, and sewage plant outfalls. In addition, pollution occurs from direct runoff from agricultural lands and from shore and bank erosion.

The water quality of the St. Clair River is directly related to the quality of the water from Lake Huron and the Black, Pine, and Belle Rivers. The water from Lake Huron is of high quality. The Black, Pine and Belle Rivers are located in the least densely populated portion of the study area. The water quality throughout these basins is generally good except at or near outfalls of combined sewers, industry, and municipal sewage treatment plants. Where these streams discharge into the St. Clair River, the water quality of the river is degraded. Except for localized increases in coliform counts for short but variable distances below municipalities, the water quality of the St. Clair River is good.

In general, the quality of the water in Lake St. Clair is good, because of the inflow from the St. Clair River. The Clinton River, however, receives discharges from many sewage treatment plants and combined sewer overflows

before discharging into Lake St. Clair. The Clinton River basin drains a large portion of the rapidly developing areas north of Detroit. The upstream reaches exhibit generally good water quality with relatively low coliform levels. As the river passes through population centers its quality decreases. Low dissolved oxygen levels and high BOD levels are found, indicating large organic loads. Fairly high levels of nitrate and phosphate noted near the river mouth indicate significant nutrient inflows. The river does not have the capacity to assimilate these pollutants and thus there are areas of contamination at its mouth and occasionally at Metropolitan Beach on Lake St. Clair.

The Detroit River from its head to its junction with the Rouge River has satisfactory water quality during normal weather conditions. However, during periods of rainfall in excess of approximately one-half inch, the combined sewer outfalls overflow the collection system along the Detroit River and discharge contaminated stormwater and raw sewage.

The River Rouge Basin includes the River Rouge, Upper River Rouge, Middle River Rouge, Lower River Rouge, and various small tributaries. The waters of the River Rouge basin are very high in both total and fecal coliforms throughout all but the extreme upstream reaches, indicating contamination of a domestic origin. The waters are moderate in suspended solids but relatively high in dissolved solids, which is reflected by high chloride levels, high iron content and increased conductance. Nitrate and phosphate levels indicate that the waters are enriched with nutrients throughout the basin; however, the monitoring station at the mouth of the River Rouge indicates a recent decline in these levels. The dissolved oxygen levels are low at a majority of the stations in the basin, with several stations having levels below 1 mg/l. The accompanying high BOD levels throughout the basin indicate the rivers carry a large organic load. Visible films of oil prominently present in the past have been virtually eliminated by new and improved treatment facilities recently installed by industries. The general quality of water throughout the basin is such that all water uses would have some degree of impairment.

Lake Erie has been classified by most water condition experts as an eutrophic lake. It is greatly over-nourished in dissolved nutrients and suffers seasonal exygen deficienty. The concentration of dissolved solids, although still below levels directly lethal to fish and food organisms, have increased significantly since 1920. The value of the fish catch, however, is declining due to the near disappearance of higher value fish stocks. Tremendous algae blooms have occurred in the past and the ultimate algae decomposition has caused widespread destruction of bottom organisms quite important to the life of many Lake Erie fishes. Mercury levels are dangerously high, but pesticide levels (DDT and Dieldrin) are moderately low. Over 85 percent of the Michigan waters of Lake Erie contain high concentrations of inorganic nitrogen and soluble phosphates. It is recognized that much of the nutrient problem originates from municipal and industrial wastewaters. Further, bacterial levels near large metropolitan centers of the size of Detroit, have been, and continue to be, a direct health hazard.

The Huron River Basin includes the Huron River, Mill Creek, Letts Creek, Portage River, Silver Creek, and Mann Creek. The waters of the Huron basin contain low total and fecal coliform levels in the upstream reaches above Ann Arbor. High total coliform levels are present in the reach below Ann Arbor with a high fecal coliform level just above Ypsilanti. Fairly high coliform levels are found below other population centers and at the mouth of the river. Suspended solids levels are lower than those in the Raisin basin and compare favorably to the median value of 33 mg/l for the southeastern region. This lower level is possibly due to the effects of the various impoundments which would allow for a natural settling of suspended solids. Total dissolved solids and chlorides appear to present no problem to the various water uses. The nitrate and phosphate levels indicate that

the waters are enriched with nutrients, particularly during the spring months, measured at the monitoring station at the mouth of the river. Dissolved oxygen levels are relatively good throughout the basin with some decrease apparent below wastewater treatment plants. The main problem in the basin is the high level of nutrients in surface waters.

The River Raisin Basin includes the River Raisin, Saline River, Wolf Creek, South River Raisin, Bear Creek, and Macon Creek. The waters in the Raisin basin exhibit a fairly low total coliform level in the upstream reaches while the fecal coliform level is high, indicating that the source of these coliforms is probably of a domestic origin. In the lower reaches, below the population centers, the total coliform level is high. The water throughout the basin is moderately high in total dissolved and suspended solids, while the chloride content is relatively low. The nitrate and phosphate levels throughout the basin would indicate that the streams are enriched with nutrients. This is particularly noticeable during the spring months. The streams, even in the upstream reaches, exhibit the high hardness levels typical of Michigan surface waters. Various stations throughout the basin have recorded low dissolved oxygen and high BOD values, which indicate a heavy organic waste load is carried by the streams. This is particularly noticeable at the monitoring station near the mouth of the river. The main problems in this basin appear to be the high level of nutrients found in the streams as well as the low dissolved oxygen values found at various locations.

There are various small streams such as Jordan Creek, Beaubian Creek, Swan Creek (St. Clair Co.), Salt River, Ecorse Creek, Swan Creek (Monroe Co.), Stony Creek, Sandy Creek, and Otter Creek, for which there is limited water quality data available.

Ground Water Resources

Ground water resources can best be described as poor to moderate as one travels from east to west over the study area. In general, bedrock formations underlying the large lake plain area consist of shales, sandstones, and limestones from which little water can be obtained. That which is obtained from bedrock sources is usually highly mineralized and unsuitable for ordinary use. Sandstone formations produce moderate yields in parts of Washtenaw, Livingston, and Sanilac counties.

Most water for domestic supplies comes from glacial deposits. In general these deposits are thinnest on the lake plain and thickens to the west and northwest. The large lake plain area which is composed mainly of lake clay is unfavorable for the development of large ground water supplies. Where outwash deposits are thick, wells will yield more than 500 gpm in the western and northwestern portion of the area. Generally, water from glacial deposits is of good chemical quality although it may be hard. Locally, objectionable amounts of mineralization occur where glacial deposits directly overlie bedrock containing highly mineralized water.

Existing Wastewater Facilities

The Southeastern Michigan area is currently served by 59 wastewater treatment plants. Forty-nine of these facilities have less than a 5 mgd capacity and all but two serve primarily single communities. The two regional systems have been developed by Detroit and Wayne County and serve the major portion of the urbanized area.

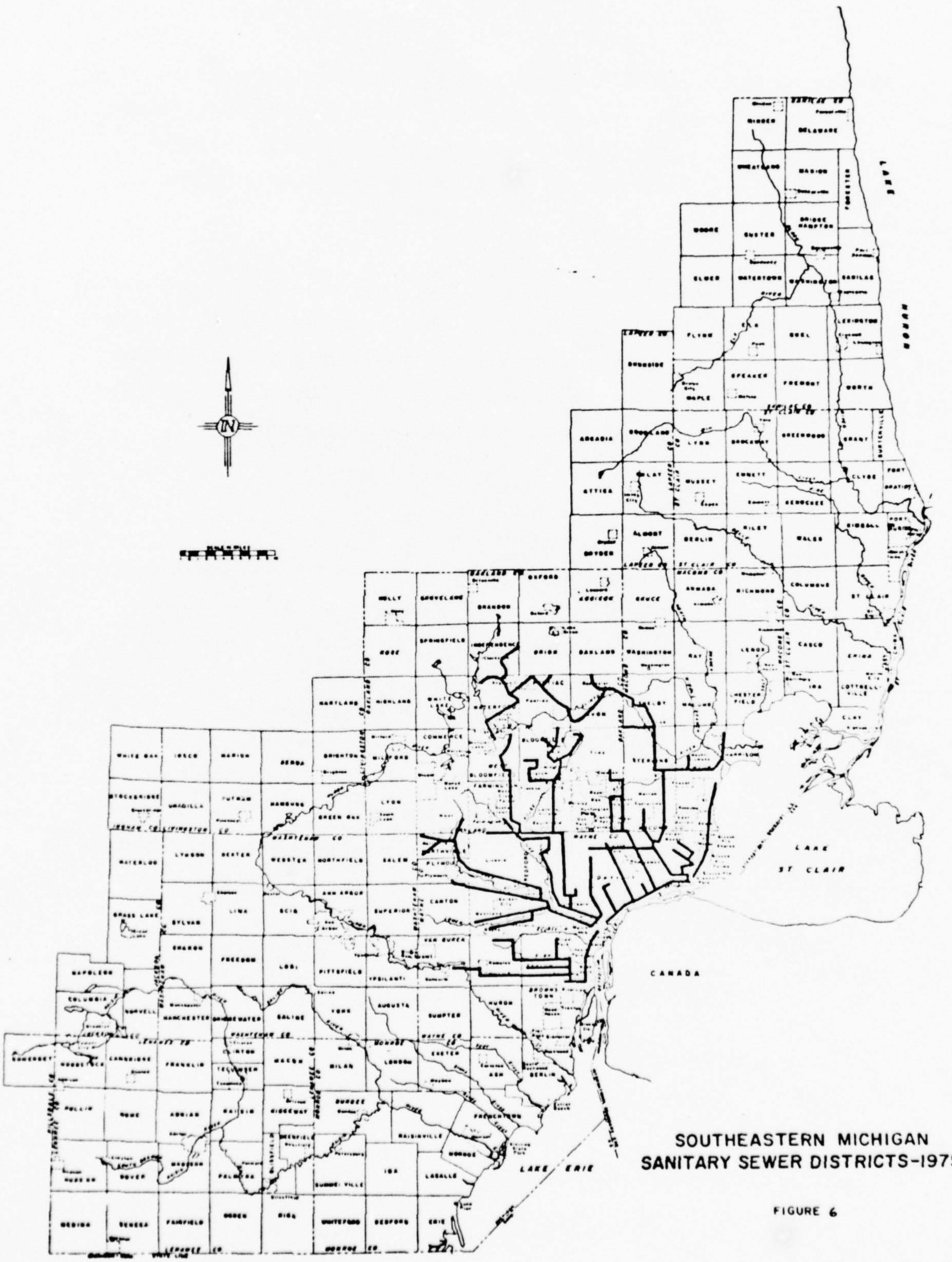
The type of treatment in each plant varies. Many of the plants were not designed to meet the current water quality standards as specified by the State of Michigan and have been or will be required to upgrade their treatment process. Table 6 presents the location of these plants, their present flows, and the treatment process they employ.

Throughout Southeastern Michigan much of the urbanized area has sewage interceptors and trunks or collectors. These facilities collect the wastewater for delivery to their local treatment plant or for delivery to a district interceptor with treatment at a regional plant serving many municipalities.

Figure 6 shows those interceptors in the study area which serve formal districts made up of several communities. These sewerage facilities are advantageous to the development of a regional wastewater collection and transmission system since the existing networks only have to be evaluated and augmented to meet proposed treatment plant configurations.

Wastewater Flow Projections

Wastewater flow projections have been developed for the years 1980, 1990, 2000, 2010, and 2020. Tables 7 and 8 present the two basic collectable sources of wastewater, municipal and industrial. These projections were based on information obtained from the Great Lakes Basin Framework Study, flow projections from individual treatment plants in the area, and data obtained from permit applications to construct structures in navigable waters. As can be seen in Table 9, the total municipal and industrial flows to the year 2000 decrease due to the expected increase in recycling of industrial wastewater. The projections were developed according to the subarea divisions presented in figure 3 on page 17.



SOUTHEASTERN MICHIGAN
SANITARY SEWER DISTRICTS-1975

FIGURE 6

Table 6

EXISTING WASTEWATER FACILITIES - 1975

Plant	Average Flow-MGD	Type of Treatment
Detroit	800	Activated Sludge
Wyandotte	65	Activated Sludge
Warren	36	Activated Sludge
Trenton	7.4	Activated Sludge
Grosse Ile	1.5	Primary
Milford	.6	Activated Sludge
South Lyon	.5	Activated Sludge
Wixom	1.1	Spray Irrigation
Pontiac	20	Activated Sludge
Walled Lake	.4	Tertiary Treatment
Rochester	1.5	Activated Sludge
Romeo	.3	Trickling Filter
Port Huron	20	Activated Sludge
Memphis	.2	Waste Lagoons
St. Clair	.7	Primary
Algonac	.3	Primary
East China	.3	Activated Sludge
Yale	.2	Waste Lagoons
Capac	.2	Waste Lagoons
Marysville	2.5	Trickling Filter
Marine City	1.5	Trickling Filter
Armada	.2	Trickling Filter

Table 6 (Continued)

Richmond	.5	Trickling Filter
New Haven	.2	Trickling Filter
Mt. Clemens	4.1	Trickling Filter
New Baltimore	.2	Trickling Filter
Utica	.4	Activated Sludge
Sterling Hgts.	3.0	Activated Sludge
Clinton Twp. #1) Clinton Twp. #2)	5.8	Trickling Filter Trickling Filter
Harrison & Chesterfield Twps.	2.0	Waste Lagoons
Chelsea	.4	Activated Sludge
Manchester	.4	Trickling Filter
Dexter	.2	Primary
Saline	1.6	Trickling Filter
Ann Arbor	14.5	Activated Sludge
Ypsilanti	5.9	Activated Sludge
Ypsilanti Twp.	7.5	Activated Sludge
Northfield Twp.	.3	Trickling Filter
Adrian	3.3	Activated Sludge
Tecumseh	1.2	Activated Sludge
Blissfield	.3	Primary
Deerfield	.1	Trickling Filter
Clinton	.2	Primary
Monroe	24	Activated Sludge
Dundee	.4	Primary
Milan	.5	Trickling Filter

Table 6 (Continued)

Carleton	.2	Waste Lagoons
Petersburg	.1	Activated Sludge
Berlin Twp.	.4	Activated Sludge
Maybee	.1	Waste Lagoons
Flat Rock	1.5	Trickling Filter
Rockwood	.6	Trickling Filter
Brownstown Twp.	.2	Lagoons
Wayne Co. Trenton	1.3	Primary
Brighton	.5	Trickling Filter
Pinckney	.1	Waste Lagoon
Loch Alpine	.1	Trickling Filter
Riverview	1.3	Primary

Table 7

MUNICIPAL WASTEWATER FLOW PROJECTIONS - IN MGD

Subarea	1970	1980	1990	2000	2010	2020
I	10	12	15	17	21	24
II	278	326	379	431	502	578
III	100	125	156	188	231	270
IV	24	35	44	56	70	85
V	15	18	20	23	28	31
TOTALS	427	516	614	715	851	988

Table 8

INDUSTRIAL WASTEWATER FLOW PROJECTIONS - IN MGD

Subarea	1970	1980	1990	2000	2010	2020
I	44	36	21	23	26	35
II	437	358	310	255	385	348
III	484	317	273	218	256	314
IV	207	200	189	171	188	248
V	44	40	36	38	46	52
TOTALS	1216	951	829	705	801	997

Table 9

TOTAL M & I WASTEWATER FLOW PROJECTIONS - IN MGD

Subarea	1970	1980	1990	2000	2010	2020
I	54	48	36	40	47	59
II	715	684	689	686	787	926
III	584	442	429	406	487	584
IV	231	235	233	227	258	333
V	59	58	56	61	73	83
TOTALS	1643	1467	1443	1420	1652	1985

Wastewater Constituent Profiles

Representative constituent concentrations must be known for designing wastewater treatment facilities to meet a high degree of pollutant removal and reliability. Sampling and testing programs to determine the characteristics for stormwater flows as well as for municipal-industrial flows have been undertaken by other agencies. This data and information received from the existing treatment plants in the area served as the base for developing the wastewater constituent profiles.

Three dry weather profiles for sanitary flows have been developed for designing municipal-industrial plants. A single profile was developed for plants at Detroit, Huron River, Wyandotte, and Port Huron. The information used for this development came from an extensive analysis of the Detroit sewage treatment plant influent and from information received from visits to the Port Huron and Detroit plants. This profile was selected to be representative of municipal-industrial flows of the Southeastern Michigan Area. Separate profiles were developed for Monroe and Adrian because of specific industrial differences in these service areas. Monroe has a significant amount of paper mill waste which makes its profile different from the other Southeastern Michigan profiles. Adrian and East China because of its rural setting, is not as highly industrialized as the other plants. This is reflected in its individual profile. These three profiles are presented in Table 10.

Stormwater runoff in Southeastern Michigan is conveyed by combined or separate sewer systems. In order to design treatment facilities for the control of stormwater pollution, representative constituent concentrations must be determined for each type of stormwater flow in the study area. Two sampling and testing programs to determine the characteristics of separate stormwater and combined sewer overflows were conducted in Southeastern Michigan. The constituent data from these studies formed the basis for the representative values. The studies examined discharges from one separate sewer system, the Allen Creek Drain in the city of Ann Arbor, and two combined sewers, the Conner Creek and the Milk River interceptors, both parts of the Detroit system.

Table 10

DRY WEATHER WASTEWATER PROFILES

MUNICIPAL-INDUSTRIAL

		Detroit Huron River Wyandotte Port Huron	Monroe	East China Adrian-Tecumseh
BOD_5	mg/l	132	174	225
COD	mg/l	350	348	500
Suspended Solids	mg/l	226	143	300
Volatile Suspended Solids	mg/l	158	100	250
Settleable Solids	mg/l	129	136	NA
Phosphates-P	mg/l	11.7	13	13
Ammonia-N	mg/l	7.5	11.3	10
Nitrates-N	mg/l	0.051	NA	0.4
Nitrites-N	mg/l	0.002	0.011	NA
Organic-N	mg/l	13.3	3.1	15
Cyanide	mg/l	NA	NA	1.0
Iron	mg/l	8.03	1.48	10
Copper	mg/l	0.36	0.07	0.5
Cadmium	mg/l	0.015	NA	0.015
Nickle	mg/l	0.52	0.01	0.5
Zinc	mg/l	0.44	0.05	0.5
Lead	mg/l	0.16	0.13	0.2
Phenols	ug/l	588	40	NA
Oil and Grease	mg/l	71	43	45
Coliforms	MPN/100 ml	21.6×10^6	51.6×10^6	NA
Chlorides	mg/l	184	NA	NA
p^H	range	6.8 - 7.5	6.6 - 7.4	NA

NA - Data not available.

The arithmetic means of selected constituents were reported or developed from the data for these three areas. Using these values, sound engineering judgments were used to determine reasonable representative constituent concentrations for both combined and separate sewer overflows in Southeastern Michigan. These representative concentrations are shown in Table 11.

The key to developing a successful system for limiting pollution from stormwater sources revolves around the ability to store peak stormwater discharges and effectively control their release to a treatment facility. After the storage facilities were designed, it became necessary to determine the effluent profiles facilities for use in designing stormwater treatment plants.

At each storage facility, variable amounts of separate storm and combined wastewater would be mixed. In addition, preliminary investigations have shown that the storage facilities would produce the equivalent of primary settling. These two factors resulted in an individual effluent profile from each stormwater storage lagoon. Influent profiles were formed by combining the parameter values for combined and separate storm sewer discharges in the same proportion as their volumes being stored at the lagoons. The effect of primary settling would result in a percent reduction of each parameter. This percentage value was determined from data which had been collected on similarly stored stormwater and applied to the previously developed influent profiles. The result was the effluent profiles shown in Table 12.

<u>Wastewater Reuse Opportunities</u>

The implementation of a regional wastewater treatment system in Southeastern Michigan would result in the generation of a large quantity of high quality effluent at great economic cost. Efforts are continually being investigated to defray this cost by making use of the renovated water or the by-products of the treatment process.

Direct use of municipal wastewater is becoming attractive in many areas of the country because of the shortage of suitable raw water for

Table 11

REPRESENTATIVE CONSTITUENT CONCENTRATIONS FROM COMBINED AND SEPARATE STORM SEWER DISCHARGES IN SOUTHEASTERN MICHIGAN

PARAMETER	COMBINED	SEPARATE
BOD Mg/l	142	28
COD Mg/l	350	325
Suspended Solids Mg/l	247	1470
Settleable Solids Mg/l	238	1150
Total Phosphate Mg/l	9.5	5.0
Volatile Solids Mg/l	221	358
Oil & Grease Mg/l	45	15
Ammonia - N Mg/l	12.6	1.0
Nitrate - N Mg/l	0.5	1.5

Table 12

EFFLUENT PROFILES FROM STORMWATER STORAGE FACILITIES

		East China Plymouth or Ypsilanti Macomb County	Monroe County (1)	Monroe County (2)
BOD_5	mg/l	30	45	40
COD	mg/l	90	120	100
Suspended Solids	mg/l	400	250	300
Settleable Solids	mg/l	100	75	75
Phosphates-P	mg/l	6	7	6.5
Volatile Solids	mg/l	160	125	120
Oil and Grease	mg/l	20	30	25
Ammonia-N	mg/l	3	7	4.5
Nitrates-N	mg/l	1.5	1	1

(1) For 1,000 mgd flow rate.

(2) For 1,400 mgd flow rate.

municipal supply. Reuse of water for industrial needs is also attractive because the quality needs of industry in many cases are not as critical and the hygienic risks associated with industrial needs are not as great as those associated with municipal supply. The use of reclaimed wastewater for agricultural needs can also be favorable in some locations because it serves two purposes: crop production can be increased; and wastewater quality can be improved.

Indirect reuse such as groundwater recharge and improved surface water quality may result in benefits as favorable as direct reuse. These alternatives offer multiple benefits by improving recreational and aesthetic conditions as well as improving natural sources of supply.

The uses made of renovated wastewater may be determined by economics of water supply and demand; however, public attitudes also play an important part in the final decision. A stigma seems to exist with the general public about wastewater reuse. However, environmental concerns coupled with public education in wastewater treatment may slowly change these attitudes.

Some raw water sources for municipal supply are nothing more than diluted sewage effluent. Treatment costs are high but, the final quality of the water is hygienically safe. In other areas, municipal supplies have been supplemented during shortages by wastewater reuse with the same results. However, the criteria for selecting a raw wastewater source as defined by the Public Health Service is: "The water supply should be obtained from the most desirable source which is feasible, and efforts should be made to prevent or control pollution of the source."

As in many of the Great Lakes areas, the scarcity of a high quality raw water supply in Southeastern Michigan is not critical enough to warrant direct municipal use of renovated wastewater now, or in the near future. On the contrary, Table 13, which shows the results of an analysis of a representative water sample taken from the Detroit water intake in the Detroit River, confirms the fact that large volumes of high quality

water are available at a source located at the center of the metropolitan area. The availability of this high quality natural water as a raw water source far outweighs the potential problems associated with municipal reuse of renovated wastewater containing the toxic substances that are inevitably present in the wastewater from a major urban area. Many experts agree that failsafe devices for removal of these substances have not yet been developed and the monitoring for low levels of the same is not adequate for quality control.

Public objection to wastewater reuse for municipal supply is anticipated. Even with the good quality water available in the Detroit River, the Detroit Metro Water Department has chosen to augment their present intake facilities by building a second intake in the Lake Huron area to obtain raw water of even higher quality (see Table 14). The position of the Detroit Metro Water Services Board, major water supplier in the area, has been to provide the best quality water at the most economical cost. The people in its service area agree with this policy and approve of their plans. Therefore, this study did not consider direct municipal reuse as a practical option during the planning process.

The recycling of industrial effluent is predicted for the future since the requirements imposed on industrial discharges are becoming more stringent and higher quality wastewater allows more possibility for reuse. The use of renovated wastewater by industry, however, is dependent upon various circumstances and conditions in specific geographic areas. The major industrial water users in Southeastern Michigan are located close to natural water sources. This limits the possibility that they would accept the use of treated wastewater as a viable alternative. There are possibilities for encouraging new industrial development inland from the lakeshore by providing them with large water sources that are not currently available. For example, as can be seen from the treatment facilities for alternatives described later, stormwater in the Plymouth and Ypsilanti areas could provide maximum supply rates of 225 mgd each on an intermittent basis. Additional storage facilities would have to be built, however, to regulate the flow. Similarly, stormwater treatment facilities in Macomb and Monroe Counties could provide a maximum intermittent flow of 600 and 1000 mgd respectively.

Table 13

RAW WATER QUALITY AT DETROIT WATER INTAKE ON DETROIT RIVER*

Parameter	Concentration in mg/l
COD	9.3
Dissolved Oxygen	13.0
Filterable Residue	121
Chloride	8
Total Phosphate	0.0
Total Hardness a CO_3	98
Total Alkalinity	79
Ammonia Nitrogen	0.0
Organic Nitrogen	0.33

*Laboratory Analyses of Water Samples Collected at Water Works Park on 6 December 1972 by DMWD

Table 14

WATER QUALITY IN LAKE HURON NEAR ENTRANCE TO ST. CLAIR RIVER

Parameter	Concentration in mg/l
BOD_5	1.5
Suspended Solids	40
Dissolved Solids	115
Total Phosphate	
Ammonia Nitrogen	0.03
Organic Nitrogen	0.22
Total Hardness	100
Total Coliform	Trace
Fecal Coliform	0

In alternatives employing land treatment, reuse opportunities would exist on a more uniform flow basis. For example, new power generating facilities could use the secondary treated effluent for cooling water and the heated effluent could be recycled back to a storage lagoon and later applied to the land. This process would have many benefits. The heat assumed during the cooling process would be dissipated during storage and by the spray irrigation process, thus eliminating a costly cooling problem faced by these plants at the present time. Also, the heated effluent might be beneficial to the irrigation process by extending the period of time over which irrigation could be performed.

Even in a water rich area such as Southeastern Michigan where the need for irrigation water exists only during certain short periods of the year, wastewater can be used to benefit agricultural production as well as treating the wastewater thru the irrigation process. It is not only the water that benefits the production, but also the nutrients contained in the water. This method of reuse not only recycles these nutrients but also provides a high quality renovated water for other reuse opportunities by collecting the percolate in underdrains and control ditches.

Clean water has always offered a multitude of recreational opportunities and the reuse of renovated wastewater for recreational purposes has been promoted in some areas. The abundance of natural recreation opportunities available along the shoreline and in other areas of Southeastern Michigan would be indirectly increased with improved water quality.

Potential also exists in both the urban and rural areas for direct use of high quality effluent for recreation. Urban recreation areas are sorely needed and suggestions have been made to use high quality effluent to create man-made streams and surround them by green belts for recreation purposes. In some rural areas large lakes could be created to control the release of treated water to streams. These lakes could be used for recrea-

tion much the same as storage reservoirs are used. Reuse opportunities must be considered by decision-makers in determining the cost effectiveness of future alternatives. Realization of future benefits will depend on the wastewater management system chosen. Since present water supply systems represent committed money and resources, there is considerable uncertainty about the viability of wastewater reuse for any purpose during the study period. Therefore, this study did not quantify the costs or benefits from the potential reuse options. They are described here as opportunities and must be considered in detail in relation to future growth.

Chapter 4

PLANNING OBJECTIVES, CRITERIA, AND ASSUMPTIONS

Planning objectives pertaining to wastewater management in Southeastern Michigan have been determined by Federal, state, regional, and local agencies. These provide the basis for plan formulation, impact assessment, and evaluation processes.

Objectives

The general goals of the U.S.-Canadian Great Lakes Water Quality agreement are to restore and enhance the water quality of the International Great Lakes and to prevent further pollution as a result of population growth, resources development, or increased water use.

The agreement describes some general water quality objectives that have been characterized as the five freedoms of water quality. These state that the waters of the Great Lakes should be:

1. Free from substances that will settle to form putrescent or otherwise objectionable sludge deposits or that will adversely affect aquatic life or waterfowl;

2. Free from floating debris, oil, scum, or other floating materials in amounts sufficient to be unsightly or deleterious;

3. Free from materials producing color, odor, or other conditions in such a degree as to create a nuisance;

4. Free from substances in concentrations that are toxic to human, animal, or aquatic life; and

5. Free from nutrients in concentrations that create nuisance growths of aquatic weeds and algae.

In addition to these general goals and objectives, the agreement spells out eight specific water quality objectives for the Great Lakes. This list includes specific limits covering microbiology, dissolved oxygen, total dissolved solids, taste and odor, pH iron phosphorous, and radioactivity. It also specifies five interim objectives to be used until more specific limits can be determined. The items covered include temperature, mercury and other toxic heavy metals, persistent organic contaminants, settleable and suspended materials, oil petrochemicals and immiscible substances. A non-degradation clause is also included which provides for further study on 18 specific constituents or substances.

Finally, the agreement outlines some specific program objectives and guidance. It specifies that programs and measures for Great Lakes water quality improvement shall either be completed or in the process of implementation by December 31, 1975. Some of the specific areas that are to be incorporated into water quality programs include control of eutrophication and pollution from municipal sources, industrial sources, agricultural, forestry, and other land use activities, shipping activities, dredging activities and onshore and offshore facilities. In addition, the programs should provide for the development of a joint contingency plan and the identification and control of hazardous polluting substances.

Public Law 92-500 establishes goals, objectives, and programs for improvement of water quality in the United States. The law proclaims two general goals for the Nation:

1. To achieve wherever possible by July 1, 1983, water that is clean enough for swimming and other recreational uses, and clean enough for the protection and propagation of fish, shellfish, and wildlife.

2. And by 1985 to have no discharges of pollutants into the Nation's waters.

The new Amendments also provide several general and specific objectives relating to water quality, comprehensive regional planning, and resource conservation. Those relating to water quality are:

1. the discharge of toxic pollutants in toxic amounts shall be prohibited,

2. that public participation in water quality programs shall be encouraged, and

3. that water quality programs shall emphasize the reduction and elimination of duplication of effort.

Those relating to comprehensive regional planning are:

1. that wastewater management planning be carried out on an areawide basis wherever possible,

2. that wastewater management programs be designed to control and treat all sources of wastes including point sources, non-point sources, and in-place or accumulated sources, and

3. that wastewater management plans must be developed for waste treatment needs in the study area for a 20-year period.

Those relating to resources conservation are:

1. to encourage waste treatment management which results in construction of revenue producing facilities providing for the recycling of potential sewage pollutants through the production of agriculture, silviculture, or aquaculture products and the reclamation of wastewater, and

2. to encourage waste treatment management which results in integrating facilities for sewage treatment and recycling with facilities to treat, dispose of, or utilize other industrial and municipal waste.

Objectives relating to wastewater have been proposed by state, regional and local agencies. Many of these goals and objectives are similar to the ones noted above and to each other. The following summary is a general list of these for the area.

1. To protect the surface waters of Southeastern Michigan for water supply, recreation values, and fish, wildlife and other aquatic life.

2. To use existing systems as a base for implementing a centralized water supply and sanitary sewer system.

3. To control the critical combined storm and sanitary sewer overflows through retention to reduce spills into receiving waters.

4. To eliminate industrial waste discharge to streams by requiring pretreatment and discharge to a regional interceptor system.

5. To formulate and maintain a land use development pattern that will provide the people of the region with areas that can readily be served by networks of necessary public utilities, such as, water supply, sanitary sewers and treatment plants, and storm drainage.

6. To eliminate the discharge of wastewater to inland water courses in Michigan.

These international, national, state, regional, and local objectives together with the specific study authorities formed the basis for developing the six basic Southeastern Michigan Wastewater Management Study objectives.

They are:

1. To provide a range of potentially implementable regional wastewater management plans for Southeastern Michigan.

2. To develop these plans in harmony with the existing facilities and short range plans of the governmental agencies within the region.

3. To include in the objective development of these plans, alternative technical systems for the control of pollution from municipal, industrial, and urban stormwater runoff sources.

4. To develop these technical systems to approach with the best available technology the 1985 "no discharge of pollutants" goal of the Federal Water Pollution Control Act Amendments of 1972.

5. To provide an alternative regional wastewater management plan to achieve a lesser effluent quality standard as defined by the State of Michigan.

6. To evaluate all of these regional wastewater management plans in terms of economics, social, cultural, aesthetic, institutional, and environmental considerations and display these impacts.

Technical Criteria

In order to meet the study objectives it was necessary to define performance criteria for the system design. Effluent quality criteria was the primary factor in the design of a system. Two sets of criteria were established, one to approach the "no discharge of pollutants" goal, and the second as defined by the State of Michigan.

The initial water quality goal of the study was to achieve the highest levels of wastewater treatment using the best available technology. Effluent criteria were established, therefore, to reflect three groups of wastewater constituents to be considered in the design process. These criteria were established based on the limits recommended by the Committee on Water Quality Criteria for water uses such as public water supply, fresh water and marine aquatic habitat and irrigation.

Classification I applies to substances which must be absent or completely removed. This implies reduction to the limit of detectability or to the lowest level attainable by presently available advanced waste treatment technology. Constituents included in Classification I were listed below with asterisks identifying those items reported in the wastewater profiles utilized for this study.

Pesticides	Lead*
Phenols*	Mercury
Cyanides*	Molybodenum
Antimony	Nickle*
Barium	Selenium
Beryllium	Silver
Boron	Thallium
Cadmium*	Tin
Chromium	Titanium
Cobalt	Zinc*
Copper*	Arsenic

Classification II applies to substance, which along with those in the previous list, comprise the minimum number of constituents to be considered in a system design. These constituents should be reduced to specific concentrations, however, and are identified below if they were present in the wastewater profile data used in this study.

Amonia	0.5 mg/1
Phosphorous	50 ug/1 in a lake
	100 ug/1 in a river
pH	6.0-8.5
Chloride	250 mg/1
Nitrates and Nitrites-N	10 mg/1
Coliform	10,000/100 mi

Classification III indicates substances which were to be given specific consideration as to their impact in each region. The following were identified as being significant in Southeastern Michigan and should be reduced to the lowest possible level using accepted processes.

Viruses	Setteable Solids*
BOD_5*	Volatile Solids*
Surfactants	Total Organic Carbon
Fecal Streptococci	Total Oxygen Demand
Taste and Odors	Gamma Radiation
Oil and Grease*	Synthetic Organics
Floatables	COD*
Suspended Solids*	

The constituents and levels contained in the preceding classification were developed as guidance for the initial planning phases of the wastewater management program. It was recognized early in the study, however, that in order to adequately design and determine the cost of wastewater treatment facilities, a list of critical pollutant levels would be required. A review of the information available on the constituents in

the three classifications indicated that there was little, if any, data available on many of them in terms of what constitutes the present background level in receiving waters or what would be an acceptable level of concentration for the constituents. This was due to a historical lack of adequate monitoring efforts and the high cost of analyses. Thus, a list of specific effluent quality standards was selected based on an environmental scan of data which was available. These are shown in Table 15. It was felt that if these standards were met, most of the other constituents listed in the previous classification would be reduced to a level which would approach the lowest level attainable. These pollutants would include phenols, pesticides, cyanides, most heavy metals, surfactants, oil and grease and others. Those materials, such as mercury, which could not be reduced to acceptable levels, would have to be controlled at the source. These constituents could be more easily determined after pilot plant investigations had been concluded prior to full-scale implementation. The treatment system would be designed to meet these goals 90 percent of the time and never to exceed twice the listed goals.

TABLE 15

EFFLUENT QUALITY STANDARDS

BOD	4 mg/l
COD	10 mg/l
Suspended Solids	2 mg/l
Total Phosphorus	0.1 mg/l
Amonia Nitrogen	0.3 mg/l
Total Nitrogen	3.0 mg/l

The stated goals imply a high degree of reliability. Systems must be designed to treat to the standards listed when operating at the maximum hydraulic capacity. This would require consideration of both maximum wastewater flows and flows from within the system (e.g. Filter Backwash Water, thickener supernatant, sludge recycle, etc.) Also, consideration would have to be given to such items as: auxiliary fuel, power, and chemical sources, replication of units; and flood protection.

The State of Michigan, through the Water Resources Commission, has established effluent criteria for municipal wastewater plans. In general, plants located along the Great Lakes and connecting channels would be required to provide secondary treatment and 80% phosphorus removal. Plants located on inland rivers and streams would have more stringent requirements, depending upon the character of the waste and the receiving body of water. These are defined in Table 18.

It was also necessary to develop criteria for processes resulting in discharge to the atmosphere. All such processes would be required to meet current (or when possible, projected) atmospheric emission standards defined by the State or by the Environmental Protection Agency.

Other items to be considered in design were occupational health and safety, multiple-use opportunities, and aesthetics.

Planning Assumptions

The planning assumptions were selected before starting the plan formulation process. The assumptions have been shown, by current plans for the study area, to be an effective and acceptable method of providing water and sewerage facilities to the region. These assumptions became planning constraints in line with the stated study objective that on going short term water resource plans would not be interferred with. They were separated into five broad categories consisting of: industrial wastewater, rural wastewater; resource avialability; base or existing facilities; and future water resource opportunities.

Industrial Wastewater

1. Industry will discharge to municipal wastewater systems. Considering the high degree of treatment being studied, control of all point sources is essential.

2. Industry will pretreat its wastewater to remove constituents harmful to municipal system processes.

Rural Wastewater

1. Rural wastewater in southeastern Michigan will be controlled by methods other than those considered herein. As these areas change from rural to urban, however, they will be incorporated into the wastewater systems being considered.

Resource Availability

1. Energy, chemical, and material requirements for construction and operation of the systems will be available.

2. Land requirements for treatment sites, sludge disposal, and storage basins will be available within the planning period. Institutional constraints would not prohibit the acquisition of land for these facilities.

Existing Wastewater Facilities

1. Consistant with the ongoing State of Michigan plans for the study area, the Huron River interceptor system will be built. Later in the study, funding and institutional problems forced the State of Michigan and the USEPA to reexamine the timing of the implementation of this plan but the decision to build the interceptor system is still valid.

2. Other major collection and transmission facilities in existence in 1975 would form the base system for all alternatives. These systems together with the Huron River interceptor system will capture about 85 percent of the municipal and industrial wastewater flows.

Future Water Use Opportunities

1. The Detroit water supply system will be extended to most of the study area. Many communities now using inland streams would switch to this more dependable source.

2. Municipal reuse of treated wastewater within the existing and expanded municipal water supply system will not be politically or socially acceptable within the planning period.

3. The ongoing State of Michigan plan, Plans for Water Quality Management, Phase II for Southeastern Michigan, would provide the base information for the development of a plan based on state water quality criteria.

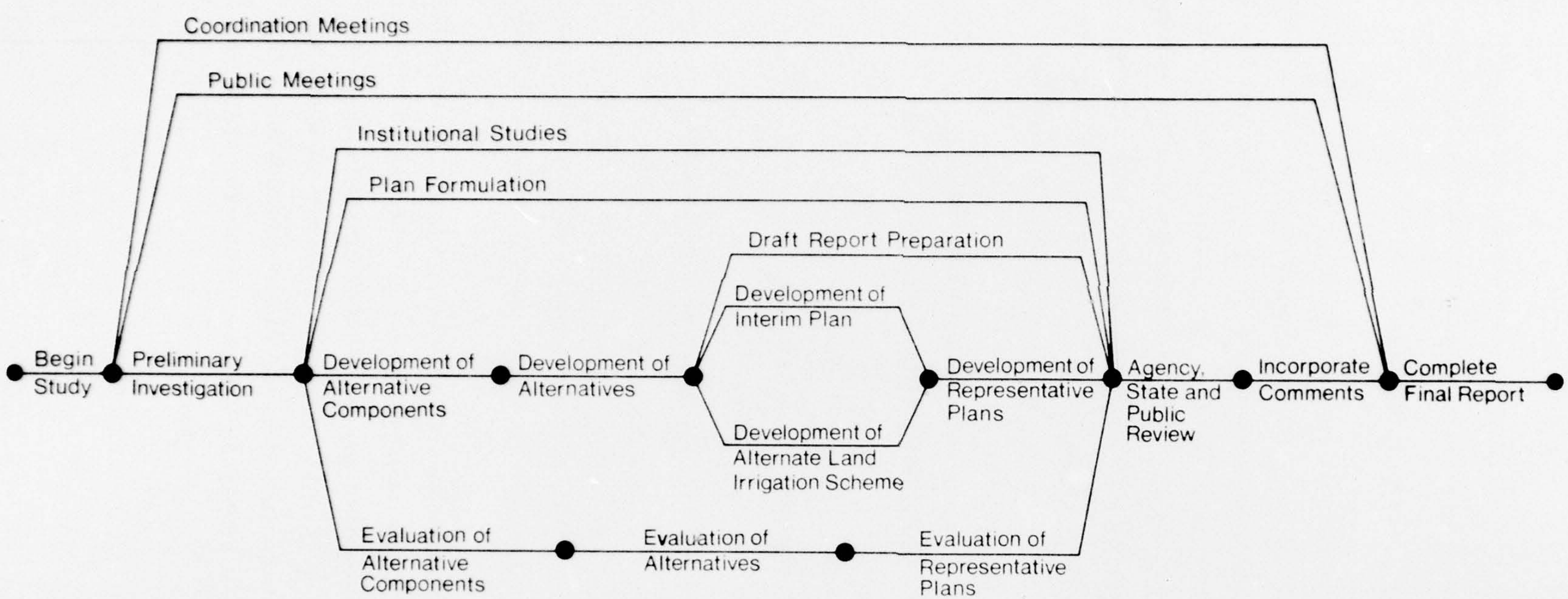
Plan Formulation Methodology

The Detroit District Wastewater Management Study was conducted in three stages as shown in the network diagram in Figure 7. As can be seen from this diagram, the study was a highly integrated composition of engineering design, plan formulation, evaluation, public participation, and coordination processes.

The first stage consisted of initial investigations and the development of technical information which led to the formation of a range of wastewater management alternative components. A multitude of wastewater control systems and processes within six areas of wastewater management were reviewed and designed. From this, technical systems and facilities for various portioms of the study area were developed which, when combined, could result in the highest level of treatment at the minimum financial cost. These became the technical components used to form total wastewater management alternatives in stage two.

Stage two resulted in the formation and evaluation of eleven alternatives which cover the entire range of wastewater management consideration and impacts, including: wastewater treatment, collection and conveyance, stormwater control, sludge handling and disposal, cost estimates, and estimates of land, chemical and energy requirements. In addition, a plan was derived from the State of Michigan's current water quality plan to provide a comparison and to show the tradeoffs involved in selecting between alternatives designed to meet different water quality standards. The impacts of these alternatives were evaluated as to their ecological, hygienic, economic, agricultural economic, social and aesthetic considerations.

Stage three resulted in the formation of Representative Plans. The evaluation of the second stage alternatives pointed out changes which could be made to improve the overall acceptance of the most favorable of these alternatives. When these changes were made, the Representative Plans



SOUTHEASTERN MICHIGAN WASTEWATER MANAGEMENT STUDY
GENERAL STUDY NETWORK

Figure 7

were the result. The impacts of these three wastewater management plans were evaluated in the same manner as the eleven second stage alternatives.

Development of Preliminary Design Information

Initial investigations were undertaken to develop a range of technical components which could be combined to form complete wastewater management alternatives. The procedure consisted of the review and design of a multitude of wastewater control systems and processes which, when combined, could result in the highest level of treatment at the minimum financial cost. Six areas of wastewater management were investigated. They included three methods of wastewater treatment and three other components which are vital to a total wastewater management system. The six areas investigated and designed were:

1. Advanced (Biological) Wastewater Treatment
2. Independent Physical-Chemical Treatment
3. Land Treatment
4. Stormwater Collection and Storage
5. Collection and Conveyance Systems
6. Sludge Handling and Disposal

These various areas are discussed in the following paragraphs.

Advanced wastewater treatment (also called Advanced Biological Treatment) as used in this report can be defined as a system which uses the conventional preliminary, primary, and secondary biological processes as a base with additional or tertiary processes used to achieve a higher quality treatment.

The preliminary and primary processes remove, by screening and settling, a major portion of the sewage solids. About half of the total pollution load from the wastewater can be removed by these two steps. Secondary treatment is an operation in which biological action is encouraged to promote reduction of dissolved organic materials in the wastewater. This is accomplished by artifically supplying oxygen to bacteria which use the organic

matter contained in wastewater as a source of food and convert it to carbon dioxide and water. In the past most wastewater treatment facilities stopped after secondary treatment. (See figure 8.)

In order to achieve the effluent quality goal of this study, however, a high level of tertiary treatment would be required to reduce concentrations of phosphorus, nitrogen, suspended solids, dissolved organic materials, several metallic ions, and other undesirable constituents. Processes which may be used to achieve this advanced treatment include, chemical clarification, nitrification - denitrification, filtration, chemical oxidation, activated carbon adsorption, and several "ultrapurification processes." Many of these processes are identical with those used in independent physical-chemical treatment systems, described below, with the exception of nitrification-denitrification which is a biological process employed for removal of amonia and nitrate nitrogen. (See Figure 9.)

Independent physical-chemical treatment uses no biological treatment processes. Instead, after receiving normal preliminary treatment, physical and chemical processes are not used to reduce the concentration of pollution constituents. (See Figure 10.)

Chemical clarification is employed to separate settable suspended solids from wastewater and to remove soluble phosphorus and metal ions. Dissolved organic matter is removed by activated carbon adsorption. Carbon adsorption replaces the secondary biological treatment process and will effectively adsorb those organic constituents for which conventional biological processes are effective as well as many organic wastewater constitituents not affected by conventional biological processes. Nitrogen is removed by breakpoint chlorination which oxidizes ammonia nitrogen to nitrogen gas and also results in a high efficiency of disinfection. Filtration is employed as a final process to remove any of the suspended solids carried over from preceding processes. To obtain economy of design, the final carbon adsorption can be designed as a packed bed, thus allowing it to serve the function of adsorption, filtration, and dechlorination.

FIGURE 8

SECONDARY TREATMENT

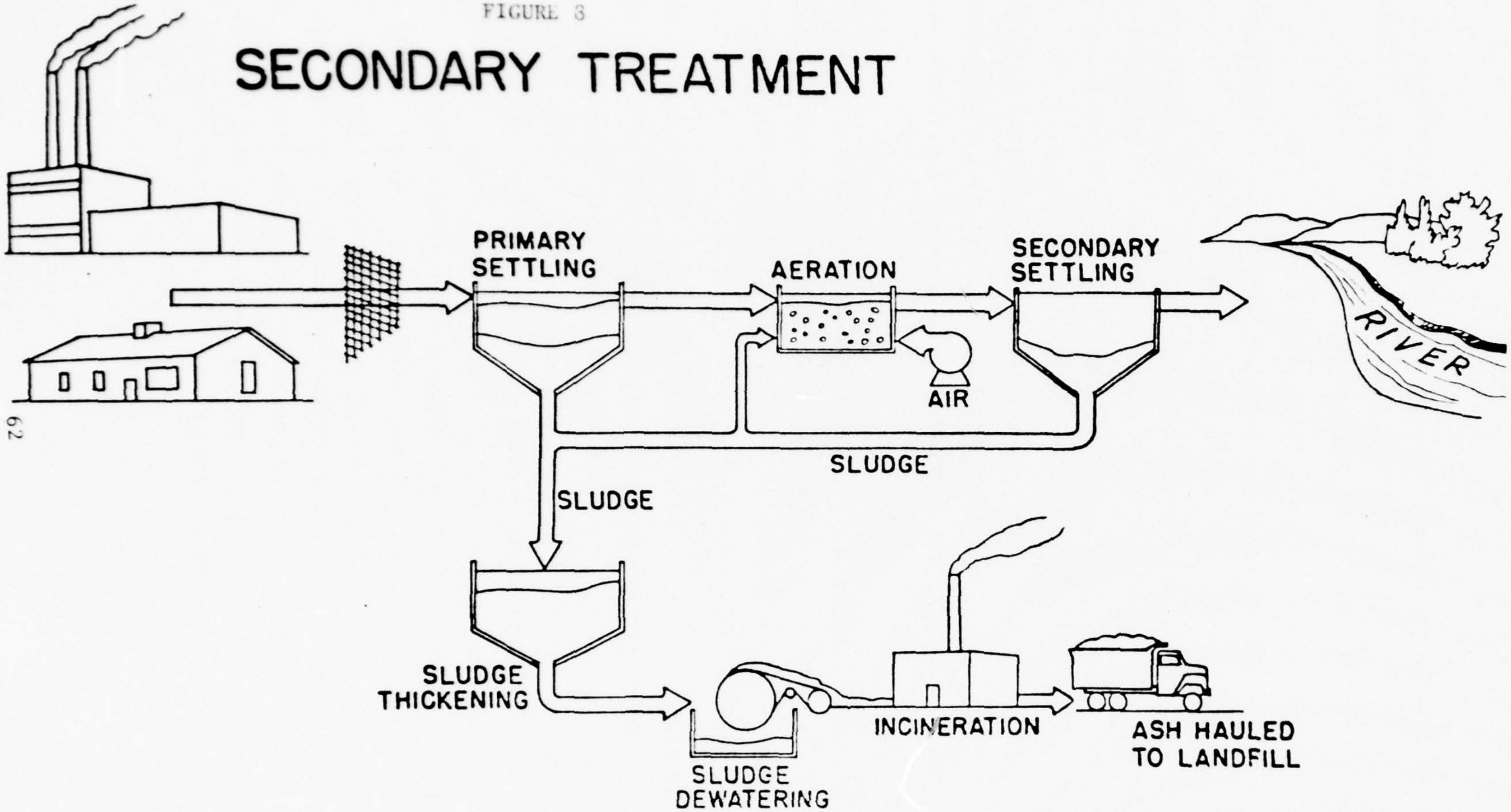


FIGURE 9

AWT PROCESSES

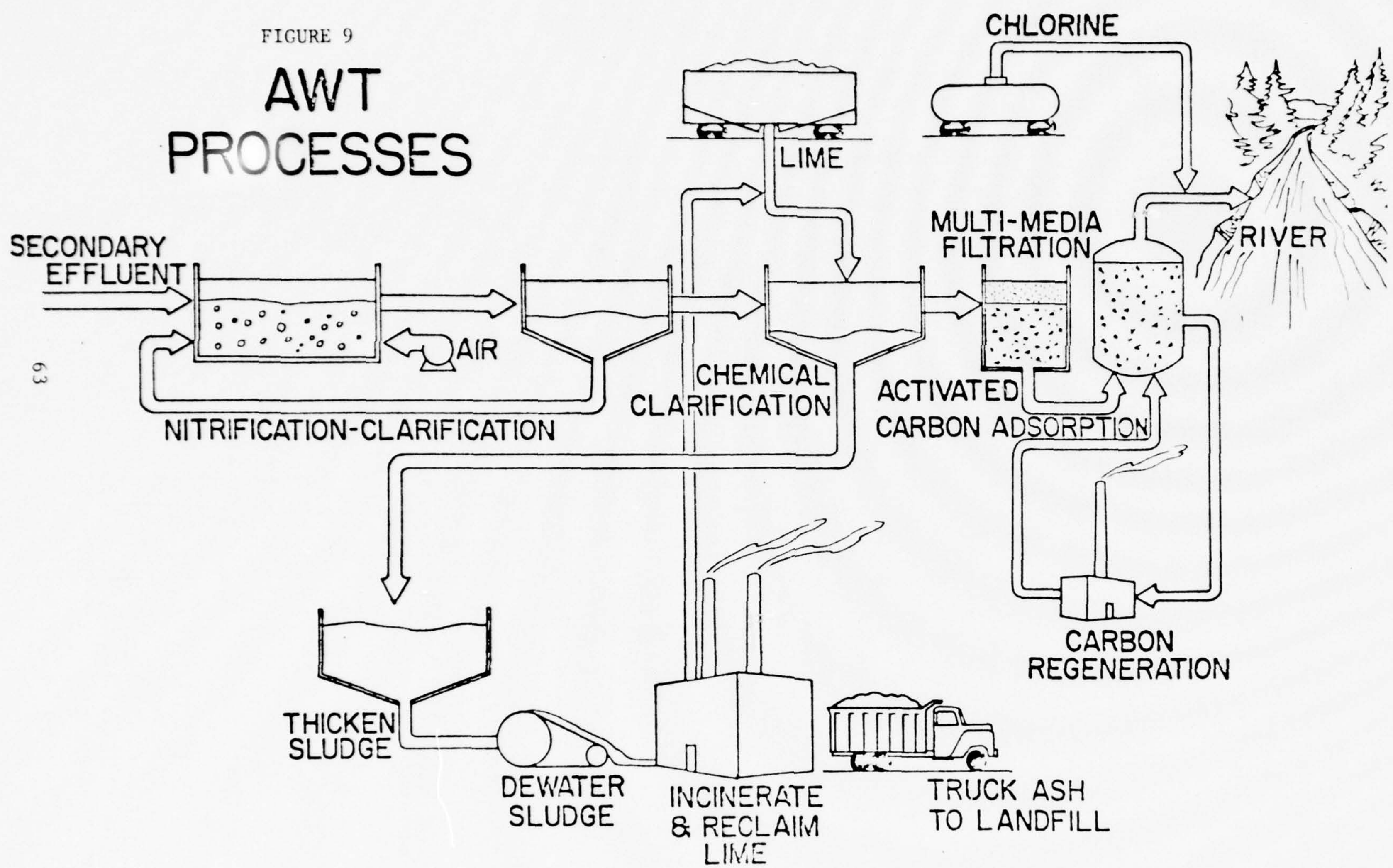


FIGURE 10

IPC TREATMENT

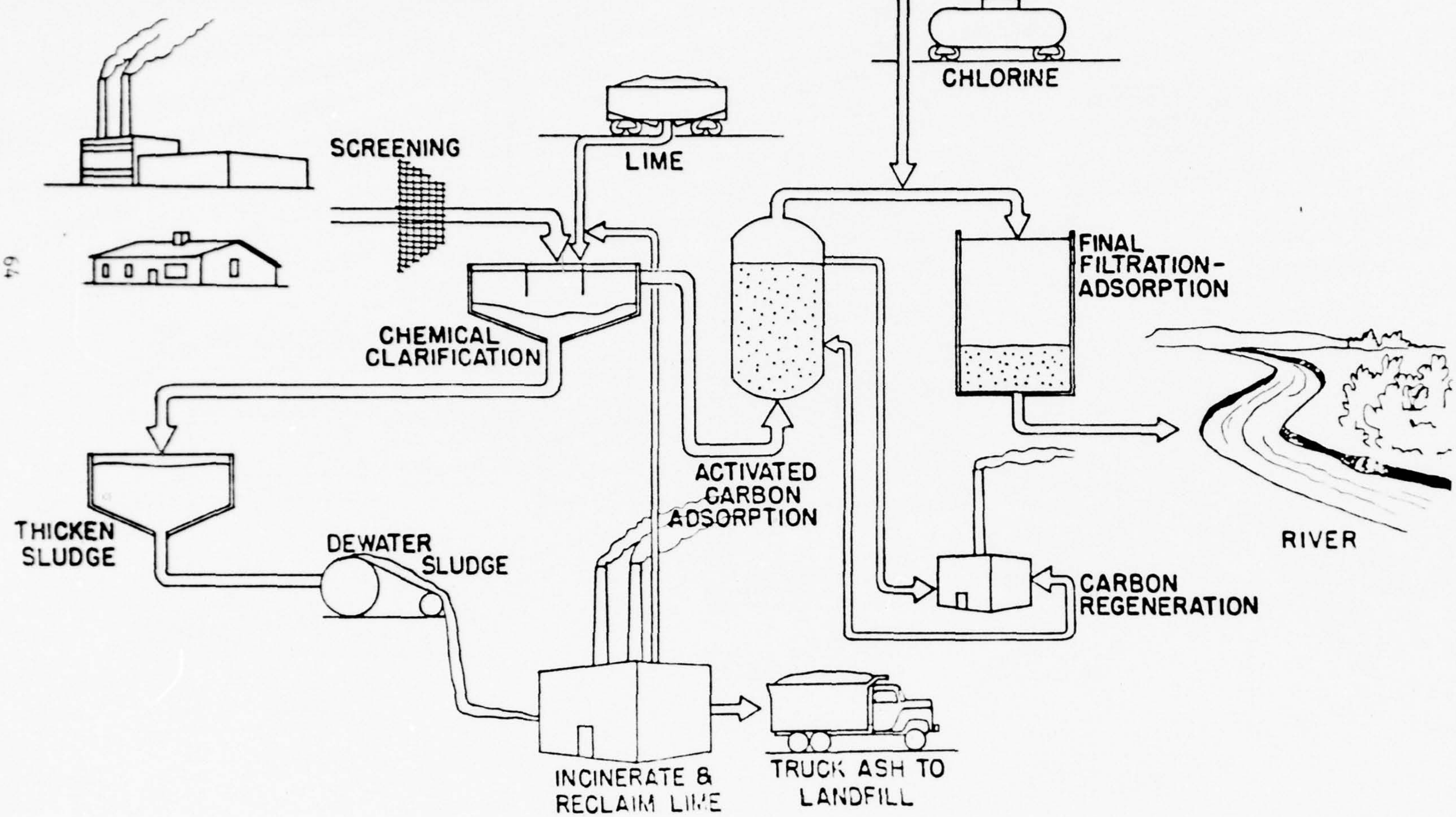
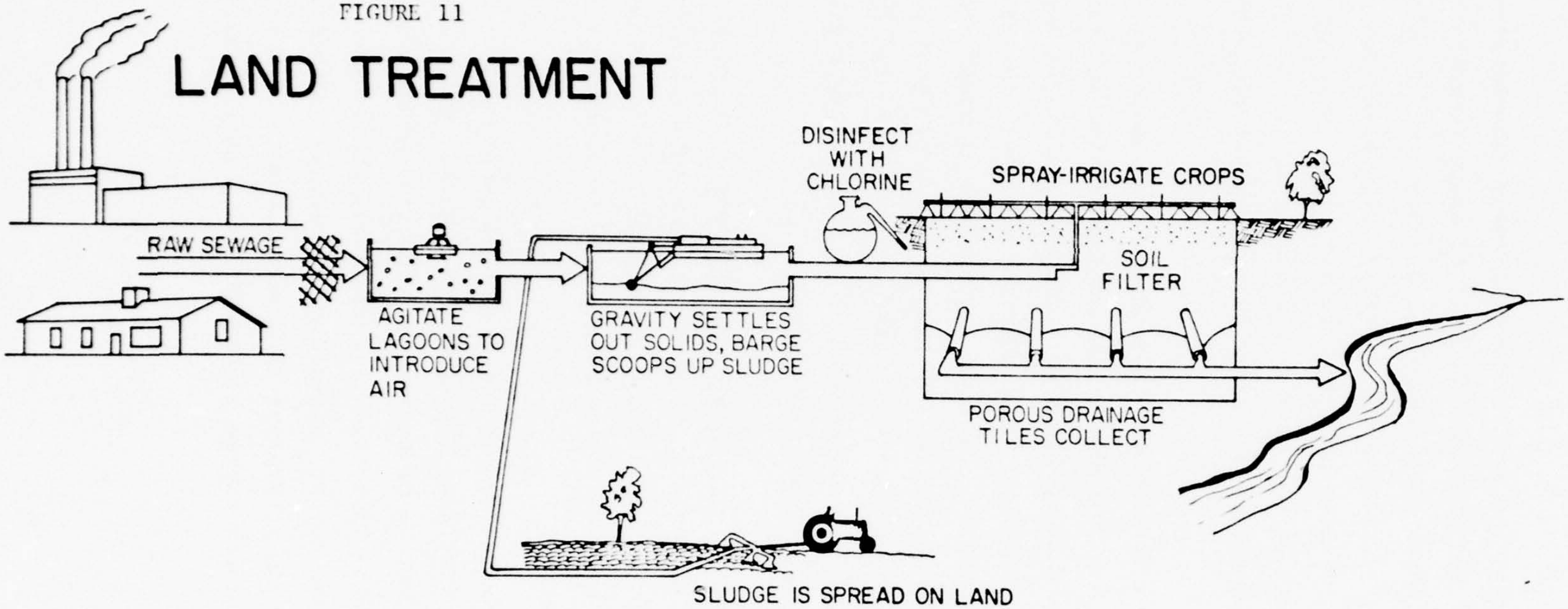


FIGURE 11

LAND TREATMENT



The Land Treatment system for wastewater management allows soil and growing plants to remove potential pollutants found in wastewater. Land treatment utilizes the natural processes of the earth's soil zone and the growing crops, relying on the existing soil biota, the soil filtering capacity, and the chemical exchange ability of the soil, to retain the nutrients for uptake by the crops. The effect is to recycle back to the environment those substances necessary to nature, but discarded as pollutants by man.

Pretreatment facilities and treatment lagoons prepare the wastewater for land application. Treatment lagoons provide the equivalent of secondary treatment prior to land application. Micro-organisms in the lagoon feed on the organic matter and reduce the degradable organic content to an acceptable level for storage lagoons. Storage lagoons are provided since wastewater can only be applied to the land during certain periods of the year in this area. They also act as settling basins and stabilize the remaining BOD. Disinfection facilities are provided at the outlets to limit the spread of potential disease organisms. (See figure 11.)

A stormwater collection and storage system was developed to control the effects of pollution from urban stormwater runoff. As the other sources of urban wastewater, municipal and industrial, are controlled, the proportion of the total pollutant load contributed by stormwater would increase without similar regulation.

Urban stormwater runoff consists of discharges from separate storm sewer systems and overflows from combined sewers. Due to the large initial volumes of stormwater to be treated and the intermittent nature of storm water runoff, initial investigations indicated that collection and storage systems would be the key to controlling stormwater pollution. These systems would reduce the stormwater flow rate and make it more receptive to sophisticated treatment before its release to a natural water body.

Several methods have been used or proposed for stormwater storage. Small storage facilities can be used to store runoff from individual developments or communities. These facilities can be above ground or below ground depending on the amount of development and space available in the area. These small storage areas could be served by individual treatment facilities or they could be connected to a larger treatment facility and the wastewater could be released at a specified rate for treatment.

Large size collection systems, incorporating deep tunnels built in hard rock at depths of 250-350 feet below the surface, could be used for partial storage and conveyance of overflows to regional storage facilities. Regional storage reservoirs could be located above or below ground, depending upon the advantages at each location. From the large regional reservoir the water would be treated and released to the natural water system.

In some existing collection systems, such as Detroit, a substantial amount of storage capacity already exists and can be controlled by gates and inflatable weirs. This would provide for selective prevention of spills and overflows and help control the wastewater flow rate to existing treatment facilities.

Collection and conveyance systems transport the water borne wastes from municipal, industrial, and stormwater sources to treatment sites in a complex arrangement of underground transmission lines. These systems are often the most expensive part of a total wastewater management system; consequently, their importance cannot be taken lightly.

Troughout the study area, municipalities have local sewerage systems, interceptors, and trunks or mains. These sewerage facilities are advantageous to the development of a regional wastewater collection and transmission system, since the existing networks only have to be evaluated and augmented to meet the proposed treatment plant configurations.

Conveyance systems transport large quantities of water from one point to another. The systems may be in the form of open channels, gravity interceptors, force mains, or deep tunnels. The conveyance systems needed for this study would transport wastewater from equalization lagoons to land treatment sites, convey renovated water from land treatment sites to discharge points, convey treated water from lagoon treatment systems to isolated irrigation sites, and transport raw wastewater from significant collection points to treatment plants or lagoon treatment sites.

Sludge handling and disposal is a critical portion of the design of any wastewater treatment system and the final design is not usually selected without extensive bench and pilot scale investigations at the proposed plant site.

All wastewater treatment methods investigated would produce a sludge of some type, and the method by which sludges would be handled or disposed must be weighed in the evaluation of a treatment method. Although sludge characteristics vary somewhat with different treatment methods, alternatives for disposal are limited. The three methods investigated were sanitary landfill of partially dry sludge, incineration (or in the case of lime sludges, recalcination) and land application. Power consumption, resource requirements, land use considerations, ecological effects, and economics developed in these investigations will be important items to be considered in the selection of the final design.

Sanitary landfill of partially dewatered sludge would follow the procedures established for solid waste sanitary landfills. The sludge material would first be dewatered, using filters or centrifuges, and then filled and covered, resulting in alternating layers of sludge and earth. A fill area would be specially prepared and maintained to limit water percolation through the fill and prevent direct contract with ground water aquifers.

In the incineration and recalcination processes, sludge is burned at temperatures of 1500-1700°F. Fuel would be required to maintain furnace temperature and insure complete combustion. Afterburners and emmission control equipment would be a necessity to prevent excessive air emissions. Ash from incineration of wastewater sludges would be relatively inert and could best be disposed of by landfill. Lime clarification sludges, when recalcined, can yield significant quanitities of resuable lime.

Sludges can also be applied to lands and utilized for their agricultural value. Although raw sludge can be applied directly, initial decomposition may have toxic effects on plants. Digested sludges reduce the possibility of this problem. Sludges may be plowed into the soil as a liquid or partially dry solid, or it may be applied in trenches as a partially dry solid. The final alternative allows high rates of initial application while the first two would require lower rates over a longer period.

Finally, the method of transportation of the sludge, in whatever form, must be chosen.

Alternatives for transportation of sludge from the municipal and industrial wastewater treatment plants to the landfill sites were reviewed and cost data and energy requirements were estimated. They are as follows:

1. Pumping raw (unconditioned) sludge from treatment to disposal site for dewatering and disposal.
2. Trucking raw sludge from treatment to disposal site for dewatering and disposal.
3. Rail transport of raw sludge from treatment to disposal site for dewatering and disposal.
4. Pumping conditioned sludge from treatment to disposal site for dewatering and disposal.
5. Trucking conditioned sludge from treatment to disposal site for dewatering and disposal.
6. Rail transport of conditioned sludge from treatment to disposal site for dewatering and disposal.
7. Trucking dewatered sludge or incinerator ash from treatment to disposal site for disposal.
8. Rail transport of dewatered sludge or incinerator ash from treatment to disposal site for disposal.

Impact Identification and Measurement

Impact assessments consist of the identification and measurement of changes that would occur as a result of the implementation of a particular plan. These assessments can be either qualitative or quantitative. For example, a quantitative measurement can be arrived at and the impacts assessed when it is desired to find the number of pounds of chemicals needed in the operation of a given wastewater treatment plant of a given size. On the other hand, the number of fish in a stream if the dissolved oxygen goes from 5 milligrams per liter to 6 milligrams per liter could not be determined numerically.

Evaluation of Impacts

Evaluation is basically a decision-making tool which allows for the consideration of factors not considered in engineering design. A very elementary definition of evaluation would be the process of assigning the value of beneficial or detrimental to the impacts that result from a particular plan. These beneficial or detrimental values are weighed in terms of several broad categories: ecological, economics, social, hygienic, aesthetic and agricultural economics. An evaluation carried out in this manner would include not only a judgment of the ability of a system to achieve its primary goals but also a judgment of the effect that the system would have on the surrounding area and how that system would contribute to local, regional and national objectives. Consideration of such factors as these impacts would be useful in anticipating problems which could arise due to implementation of a plan. Early diagnosis of problem areas would thus allow design changes prior to implementation of a plan. The evaluation would finally be used to narrow the range of plans and ultimately to select the plan which, in the judgment of the decision makers, contributes the most to local, regional and national objectives.

Participation and Coordination

Throughout the conduct of the study, members of various governmental agencies and public interest groups were involved and participated in the

study through a study coordinating committee. The committee included representatives of the following agenices and groups:

Environmental Protection Agency - Region V
Soil Conservation Service, U. S. Dept. of Agriculture
Bureau of Sport Fisheries and Wildlife, Dept. of Interior
Michigan Water Resources Commission
Institute of Water Research, Michigan State University
Southeast Michigan Council of Governments
Metropolitan League of Women Voters
Detroit Metropolitan Water Department

The objectives of the committee were: (1) to provide prospective alternative plans, (2) to serve as a forum for varying technical and public views to insure full cooperation and (3) to provide insight and review on alternative proposals as spokesmen for their respective organizations.

The State of Michigan concurrently conducted a regional study for much of the same Southeastern Michigan area based on a lower level of wastewater treatment. This study provided most of the information used to develop the Interim Alternative presented later in this report. The State and the Corps coordinated fully, in this respect, eliminating duplication of effort while providing information pertinent to the development of each study.

The Institute of Water Research, Michigan State University, was the prime ecological evaluator. Its staff provided guidance throughout the development of technical systems with regard to favorable and unfavorable impacts of alternative technical choices. They also evaluated the various plans and provided total impacts on the region.

The Soil Conservation Service provided large amounts of soil data required in the evaluation and selection of lands suitable for land irrigation. They have also served as liaison between the Corps and the people in these respective areas with whom they deal in their normal activities to encourage them to take a more objective look at land irrigation of treated wastewater.

The Southeast Michigan Council of Governments was involved in the development of population projections and projected expansion of service

areas. It provided information regarding current plans for the study area in the field of water supply and wastewater facilities for help in defining existing and proposed facilities.

The general public and other interest groups were involved through a series of public meetings, informal workshops, and seminars or presentations conducted during the course of the study. A public information brochure, "The Search for Clean Water," presenting the developments of the first phase of study, was distributed. These tools were used to inform interested people about study progress, to solicit their reaction to any and all proposed alternatives, and to gather pertinent information. The reactions and information obtained were used to help form the initial alternatives and to help in the later screening process. The impact of the coordination and public involvement programs is discussed in more detail later in this report.

Institutional Arrangements

For the purpose of this study, institutions are defined as organizations, authorities, and relationships by which wastewater management systems and controls are implemented. The purpose of an investigation of institutional management schemes is to analyze the capabilities of existing and proposed wastewater management organizations relative to selected technical wastewater management systems. A number of institutional management schemes, each possessing suffieient authority to plan, construct, operate and maintain the systems developed during the study, have been proposed for the Southeastern Michigan area. These institutions can be classified in six categories which cover management on various levels of political interaction. These six classifications involve wastewater management by:

- State Agency or Utility
- Regional Agency
- County Agency
- Municipal or Local Agency
- Water and Sewage Authority
- Management thru Intergovernmental service agreements (referred to as intercounty agreements)

1. STATE AGENCY OR UTILITY - This type of institutional mechanism involves an executive or departmental agency to the State actually undertaking the direct performance of an urban function. In practice, aspects of functions may be transferred to a State agency rather than the total function. For example, if a State agency provides water for a metropolitan region, this agency is usually responsible for the actual source of the water supply plus the major trunk lines to convey the water from the source throughout the metropolitan region. Local distribution systems, however, are often left to the localities themselves.

2. REGIONAL AGENCY - The multiple purpose District/Authority represents an independent unit of government established through State law to perform a number of services in all, or most portions, of a metropolitan area. The multiple purpose District/Authority may be established initially with only 1 or 2 actual functions; however, the enabling legislation vests, in the area affected, the capability for the District/Authority to take on additional functions as the need arises.

3. COUNTY AGENCY - Under this type of an arrangement, the county government increases its provision of services which are normally of a municipal nature to include the entire county. This action requires the transfer of functions from muncipalities and any special districts together with the gradual expansion of activities in unincorporated urban areas. It may be necessary for the State to grant a number of functional powers to counties in metropolitan areas. Act 342, Public Acts of 1939 allows a county to provide wastewater management services within its boundary as well as in consenting neighboring governmental units. (Unless otherwise identified, Public Acts refer to current wastewater management legislation in the State of Michigan).

Certain legislative acts stipulate that the county agency is capable of providing services within a boundary specifically limited to a local area. Act 40, Public Acts of 1956, Chapter 20, stipulates that a designated "Agency," in this case a drain commission, may provide for collection and transmission of wastewater within a county. Act 185, Public Acts of 1957, established a Department of Public Works to provide for WWM services within a county.

4. MUNICIPAL OR LOCAL AUTHORITY - The limited purpose metropolitan special district or authority is an independent unit of government organized to perform one or more urban functions throughout all or a part of a metropolitan area. In most cases, the activity is service, as opposed to regulatory; for example, water supply or sewage disposal. The financing of such an independent unit of government is primarily through service changes, sales, rents and tolls. Revenue bonds constitute the primary source of capital funds for project construction.

5. WATER AND SEWAGE AUTHORITY - Act 233, Public Acts of 1955 allows for the establishment, by consenting governmental units, of an authority to provide both wastewater and water supply services. The authority can finance facility construction by the provision of contract bonding and, in this aspect, the provisions are similar to those mentioned in Act 342, Public Acts of 1939. Full faith and credit for these bonds is established by the financial stability of the contracting governmental units.

6. MANAGEMENT THRU INTERGOVERNMENTAL SERVICE AGREEMENTS - Under such a device, one unit of government conducts an activity jointly or cooperatively with one or more other units of government. Typically, contracts may be drawn up whereby one public corporation or unit of government agrees to provide specified services to other units of government according to terms specified in the contracts. The extraterritorial power, therefore, represents the exercise of authority by one unit of government beyond its traditional political boundary. For example, the Detroit Metropolitan Water Department and the Wayne County Road Commission provide sewage service to communities under Intergovernmental Service Agreements.

The examination of these six institutional management schemes took place in two evaluations. The first was to determine the potential of five existing representative wastewater institutions created by current legislation to implement proposed regional wastewater management plans. The second evaluation examined a range of institutional management schemes which involved the combination of existing and proposed management systems.

Chapter 5

STAGE II - ALTERNATIVES CONSIDERED

DESCRIPTION OF ALTERNATIVES

The previous chapter discussed the initial investigations and the development of technical information which led to the formation of a range of wastewater management alternative components. In this chapter these components are combined to form eleven complete wastewater management alternatives. These alternatives cover the entire range of wastewater management considerations, including: wastewater treatment, collection and conveyance, stormwater control, sludge handling and disposal, cost estimates, and estimates of land, chemical, energy and manpower requirements.

Seven alternatives were formed which utilize only one of the three methods of treatment for municipal-industrial wastewater. Alternatives utilizing the same method of M & I treatment resulted from variations in plant locations and sludge handling and treatment methods. The remaining four alternatives were formed by combining the most effective wastewater management components for various parts of the area. This resulted in alternatives which contained a combination of the three wastewater treatment methods.

The alternatives are identified by names which describe the treatment method proposed for municipal-industrial wastewater and include:

Advanced Wastewater Treatment Alternative One
Advanced Wastewater Treatment Alternative Two
Independent Physical-Chemical Treatment Alternative One
Independent Physical-Chemical Treatment Alternative Two
Independent Physical-Chemical Treatment Alternative Three
Land Irrigation Treatment Alternative One
Land Irrigation Treatment Alternative Two

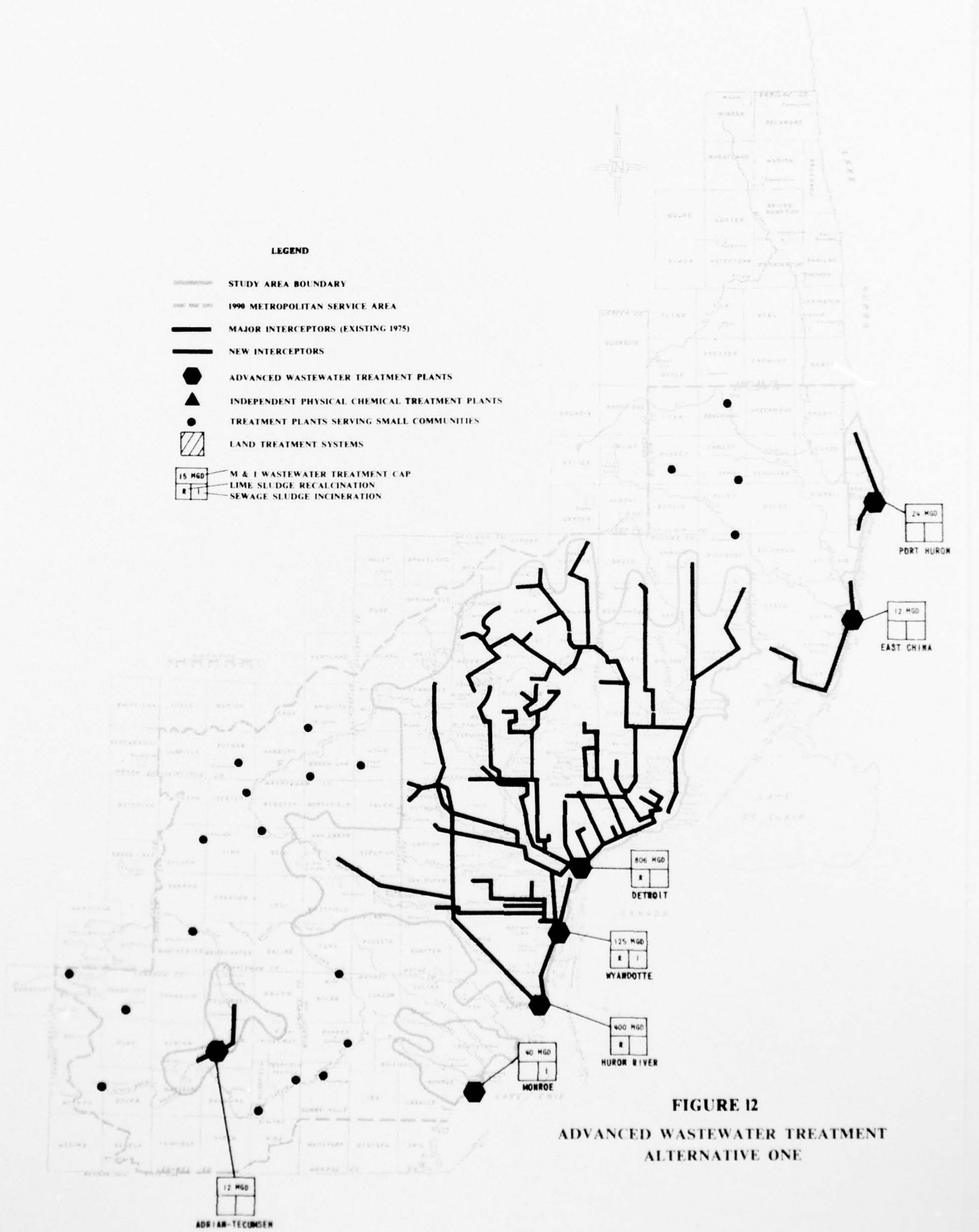


FIGURE 12

ADVANCED WASTEWATER TREATMENT ALTERNATIVE ONE

Combination Wastewater Treatment Alternative One
Combination Wastewater Treatment Alternative Two
Combination Wastewater Treatment Alternative Three
Combination Wastewater Treatment Alternative Four

Advanced Wastewater Treatment Alternative One

This alternative utilizes advanced wastewater treatment as the primary method of municipal-industrial wastewater treatment. Storm runoff would be treated by the independent physical-chemical treatment process. Sewage sludges would be dewatered and disposed of by landfill, the most cost effective method as identified by the contractor. Lime sludges would be recalcined and reused. The alternative would make use of four existing regional plants in the area, thereby maximizing use of existing facilities and minimizing loss of treatment effectiveness during the implementation period.

The system would utilize seven regional advanced wastewater treatment facilities, located as shown in Figure 12. The existing plants located at Port Huron, Detroit, Wyandotte and Monroe would be upgraded and expanded as necessary to meet the requirements of the system. New plants would be constructed at East China, near the mount of the Huron River, and east of Adrian. Additional advanced treatment plants would serve outlying communities until growth and expansion would economically justify the continuation of the regional interceptor network.

Major interceptor construction necessary for implementation of this alternative would include: an interceptor along the St. Clair shoreline in southern St. Clair County, an interceptor along the Detroit River to the Huron River, an an interceptor from Ann Arbor following the Huron River to its mouth, and an interceptor following Hannan Road north of the Huron River.

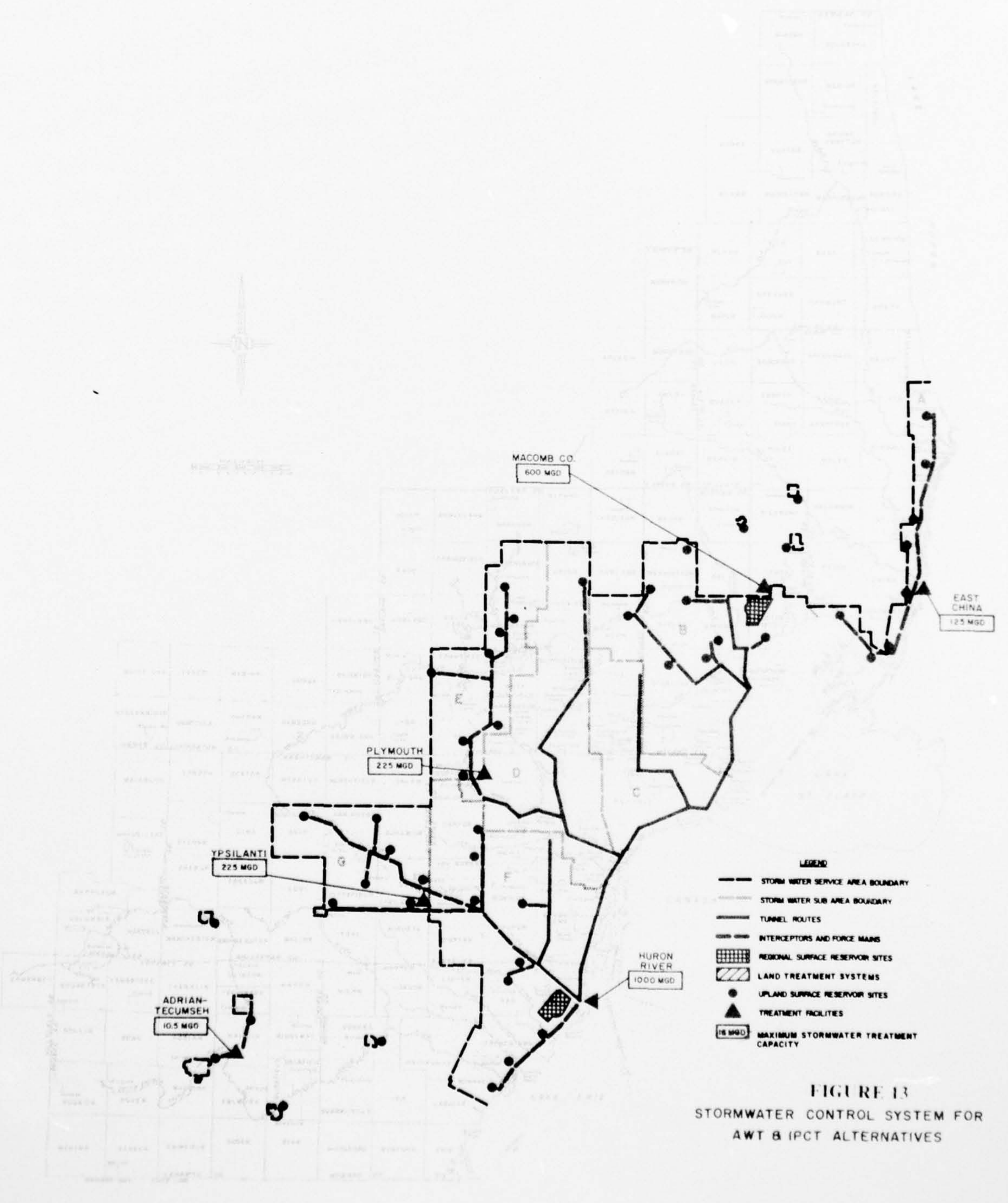


FIGURE 13
STORMWATER CONTROL SYSTEM FOR AWT & IPCT ALTERNATIVES

The system designed for handling combined sewer overflows and urban storm runoff would be essentially independent of the municipal-industrial wastewater treatment system, see Figure 13. The stormwater system would utilize forty-nine community storage reservoirs ranging in size from 80 to 690 acres. These, and two regional reservoirs of 3,120 acres each, would be used for temporary storage of peak storm flows. Treatment of collected stormwater would be carried out at six IPCT facilities designed specifically for stormwater treatment. Three of these plants would be constructed in conjunction with the municipal-industrial treatment facilities at East China, the Huron River, and Adrian-Tecumseh. These collocated plants would share specific treatment process facilities. The combined use of some of these processes can be made feasible due to the intermittant nature of stormwater treatment. Operation and maintenance workers and supervisory personnel would serve the collocated facility; therefore, the combined work force would be optimized. Another IPCT plant would be located adjacent to the regional storage reservoir in Macomb County to enable greater control of both stormwater system components and minimize disruption which might be caused if these facilities were located at separate sites. The remaining two IPCT plants would be located on the Rouge River at Plymouth and on the Huron River just south of Belleville Lake. These plants would treat the equalized stormwater flows and discharge them into the receiving stream which they would have been part of had they not been interecpted, collected, and treated.

An extensive system of interceptors and tunnels would be required to collect storm runoff and combined sewer overflows at the present points of discharge to surface waters. Normal sewer construction techniques would be utilized in less urbanized areas; however, the greater size of sewers required in highly urbanized areas and the construction problems encountered made design of hard rock tunnels necessary.

Sludges generated by the system would be handled by several methods. Primary and secondary sewage sludges would be incinerated at plants in

FIGURE 14

ADVANCED WASTEWATER TREATMENT ALTERNATIVE TWO

Monroe and Wyandotte, the ash being disposed of by landfill. The remainder of the sewage sludges would be dewatered and hauled to landfill sites in St. Clair and Lenawee Counties. Lime sludges generated at all treatment plants, with the exception of Port Huron and Monroe, would be recalcined for lime recovery. Sludges not recalcined would be disposed of in landfill areas. A major additional source of waste solids would be the solid material which would accumulate in stormwater storage facilities. That material would be disposed of by landfill, since the low organic contend of this material would make it uneconomical to incinerate.

Advanced Wastewater Treatment Alternative Two

This alternative is identical to AWT Alternative One with the exception of the methods proposed for sewage sludge handling, see figure 14. In order to limit sludge hauling and land requirements for disposal, sludge incineration and recalcination would be used extensively. Sewage sludges would be incinerated at the treatment plant sites and the resulting residue would be disposed of by landfill. Incineration of sludge significantly reduces the waste volume and results in a more stable fill material than does the dewatering process. Lime sludges would be recalcined to reclaim the lime and to reduce the waste material. At larger plants recalcination would take place on the site; however, the smaller sized plants at Port Huron, Monroe and Adrian-Tecumseh would not recalcine lime sludge at the plant sites but would haul it to the nearest plant with recalcination facilities. The amounts of lime sludge which would be generated at these smaller plants do not make it advantageous to recalcine on the site; but, with almost no increase in the capital investment for recalcination facilities, the sludge could be treated at the other sites.

The extensive use of sludge, incineration and lime sludge recalcination in this alternative results in various effects on total air emission, energy and chemical requirements, and land use, which are the most significant differences in these two AWT alternative categories.

FIGURE [redacted] 15

INDEPENDENT PHYSICAL - CHEMICAL TREATMENT ALTERNATIVE ONE

Independent Physical-Chemical Treatment Alternative One

This alternative would utilize independent physical-chemical treatment as the primary method for treatment of both municipal-industrial wastewater and storm runoff. Sludges generated during treatment would be incinerated and recalcined lime would be reused. This plan emphasizes centralized treatment and minimum land use, and would abandon all existing regional plants in the area.

Municipal-industrial wastewater would be treated in only three regional plants--the major plant located near the mouth of the Huron River and two lesser plants located in East China and at Adrian-Tecumseh. These locations, as shown in Figure 15, offer large amounts of available land for construction; whereas, several of the existing locations are severely limited for available space. Major interceptor construction necessary for implementation of the plan would include: an interceptor along the St. Clair River shoreline in St. Clair County, a major interceptor from the present Detroit plant along the Detroit River to the Huron River, an interceptor from Ann Arbor following the Huron River to its mouth, and an interceptor following Hannan Road north of the Huron River. Communities outside the area served by the regional plants would operate small advanced treatment plants until growth would justify extension of regional interceptors.

The stormwater control system would be identical to the system described under AWT Alternative One and shown in Figure 13. The collocated facilities at East China, the Huron River, and Adrian-Tecumseh would vary slightly because the M & I wastewater would be treated by IPCT processes and the size of the M & I plant at the Huron River would be significantly larger.

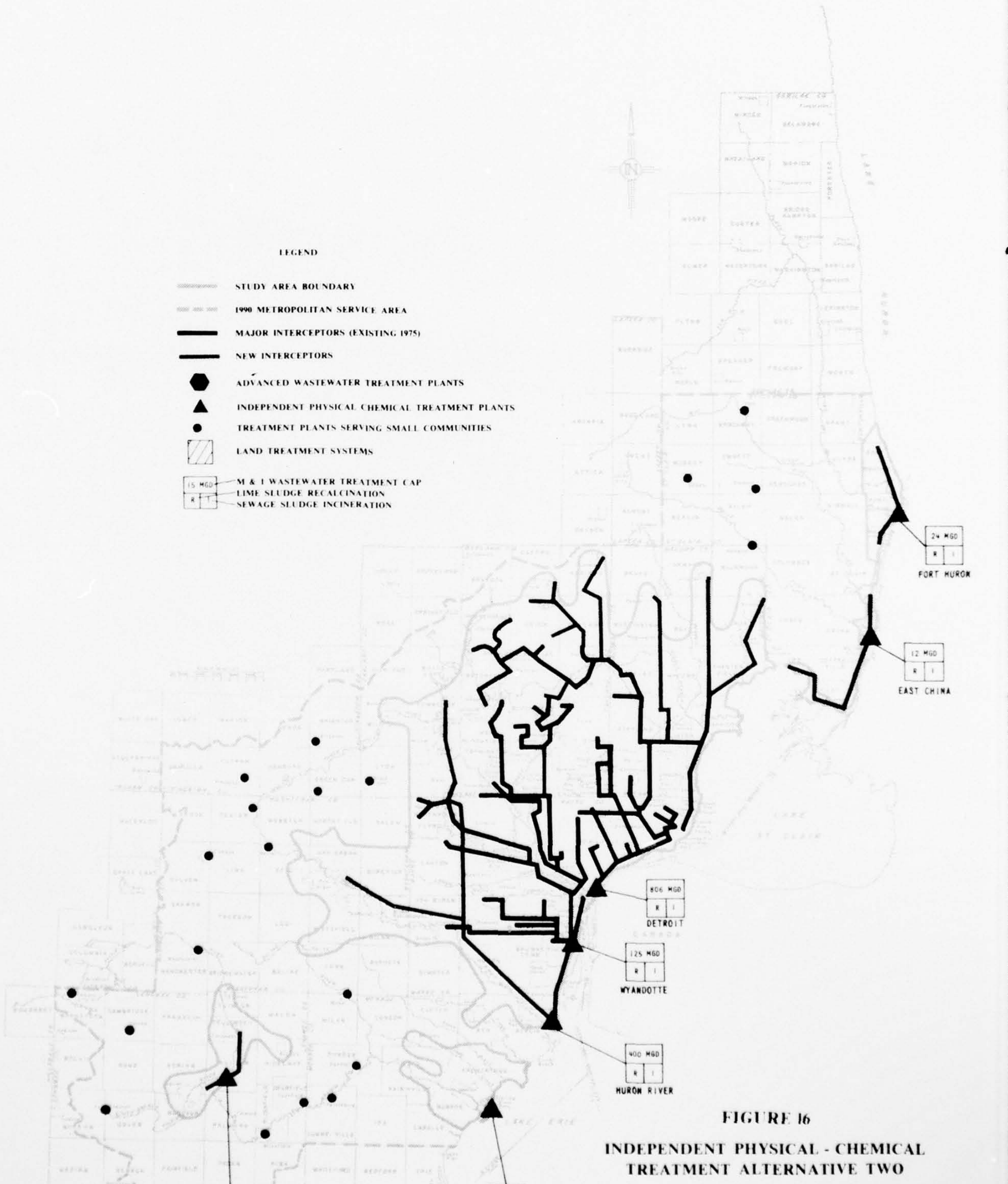


FIGURE 16

INDEPENDENT PHYSICAL - CHEMICAL TREATMENT ALTERNATIVE TWO

In order to keep land use to a minimum and reduce hauling costs, wastewater treatment sludges would be incinerated; ash would be landfilled and recalcined lime reused. A major additional source of waste solids would be the solid material which would accumulate in stormwater storage facilities. That material would be disposed of by landfill.

Independent Physical-Chemical Treatment Alternative Two

Like IPCT Alternative One, this alternative proposes the use of independent physical-chemical treatment as the primary method of both municipal-industrial and stormwater treatment. Unlike IPCT Alternative One, this alternative attempts to maximize the use of major existing treatment facilities in the regional IPCT system. These existing plants, located at Port Huron, Detroit, Wyandotte, and Monroe would involve the conversion of many facilities to IPCT processes in a phased type construction in order to maintain wastewater treatment. Three additional IPCT plants at East China, the Huron River, and Adrian-Tecumseh, would be constructed and would be completely equipped with new facilities. The interception system for this alternative is identical to the one previously presented for the AWT alternative, since the plant locations would be the same. See Figure 16.

The stormwater collection, storage, and treatment system would be identical to the one described in AWT Alternative One with the exception that the three collocated facilities, mentioned above, would vary slightly because the M & I wastewater would be treated by IPCT processes.

Sludge treatment and disposal methods would be similar to those in AWT Alternative Two. Wastewater treatment sludges would be incinerated; recalcined lime would be reused; and waste ash would be disposed of by landfill. The largest quantities of waste solids would be taken from stormwater storage facilities. The storm solids would be allowed to dry and then landfilled.

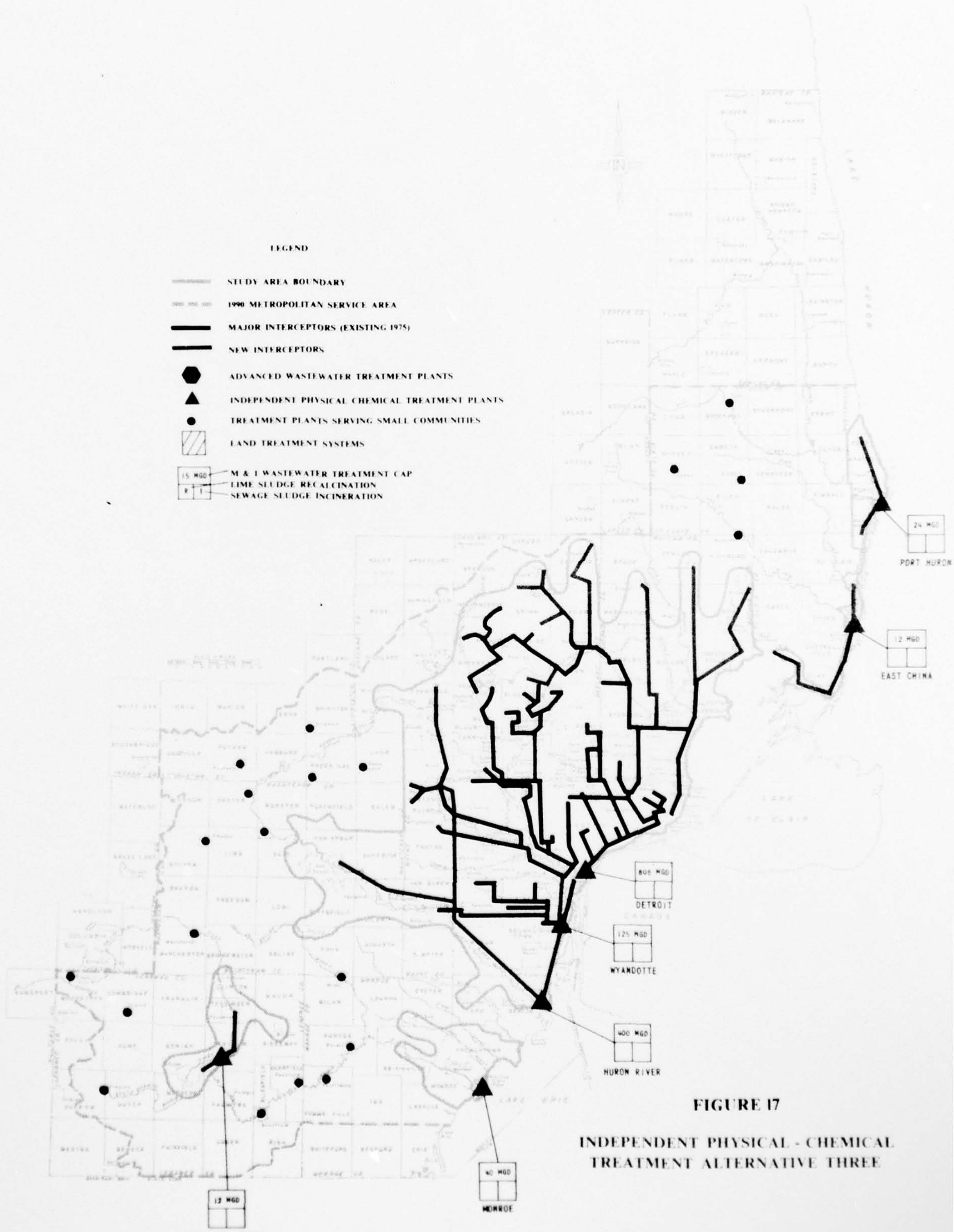


FIGURE 17

INDEPENDENT PHYSICAL - CHEMICAL TREATMENT ALTERNATIVE THREE

Independent Physical-Chemical Treatment Alternative Three

This alternative is identical to IPCT Alternative Two with the exception that no incineration processes would be employed for sludge disposal, see Figure 17. This would result in a large increase in sludge volume for disposal and a subsequent increase in land required for sludge disposal. Also lime reuse would not be possible. The advantages, gained at the cost of the additional land and chemical demand, would be the elimination of a potential air emission source and a significant reduction in energy consumption. The sludge handling and disposal methods are similar to those in AWT Alternative One; therefore, many of the differences between IPCT Alternatives Three and Two would be similar to the differences between AWT Alternatives One and Two.

Land Irrigation Treatment Alternative One

This alternative would utilize land irrigation treatment as the primary method of municipal-industrial wastewater and storm runoff treatment. The alternative would make maximum use of the recyclable constituents of wastewater by applying both treated wastewater and wastewater sludges to land for agricultural production. This alternative would, however, require abandonment of all major existing wastewater treatment facilities.

A mixture of municipal-industrial wastewater and storm runoff would receive the equivalent of secondary treatment at two major aerated lagoon systems in Monroe and St. Clair Counties and a smaller system in Lenawee County. At the lagoon sites, storage would be provided for all wastewater for a period of 155 days, since wastewater would not be applied to the land during winter months and wet periods. Treated wastewater would be chlorinated for disinfection and applied to the land. After percolation through the soil, renovated wastewater would be collected in an underdrain system and either discharged to local streams for flow augmentation or transported to major rivers for discharge.

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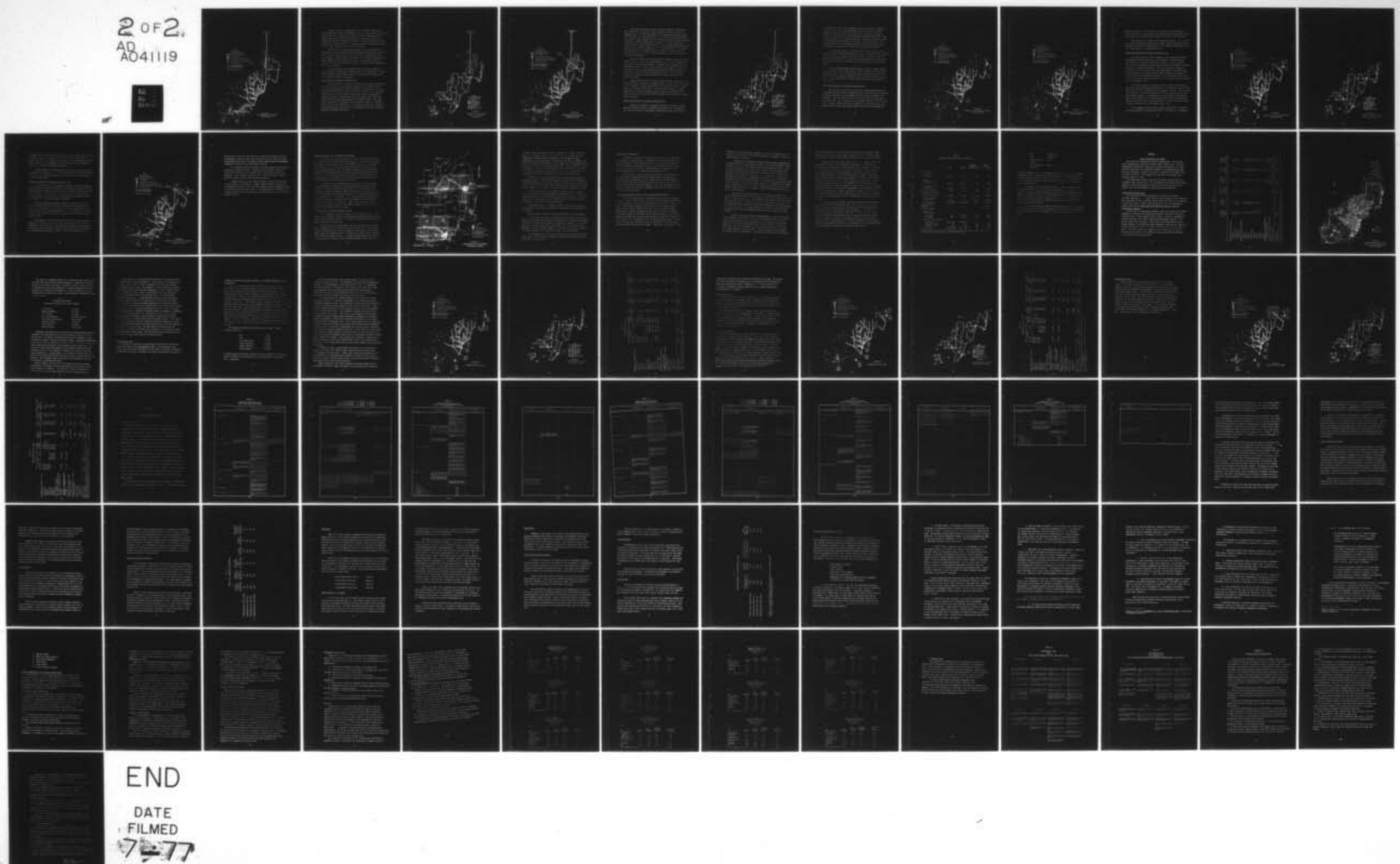

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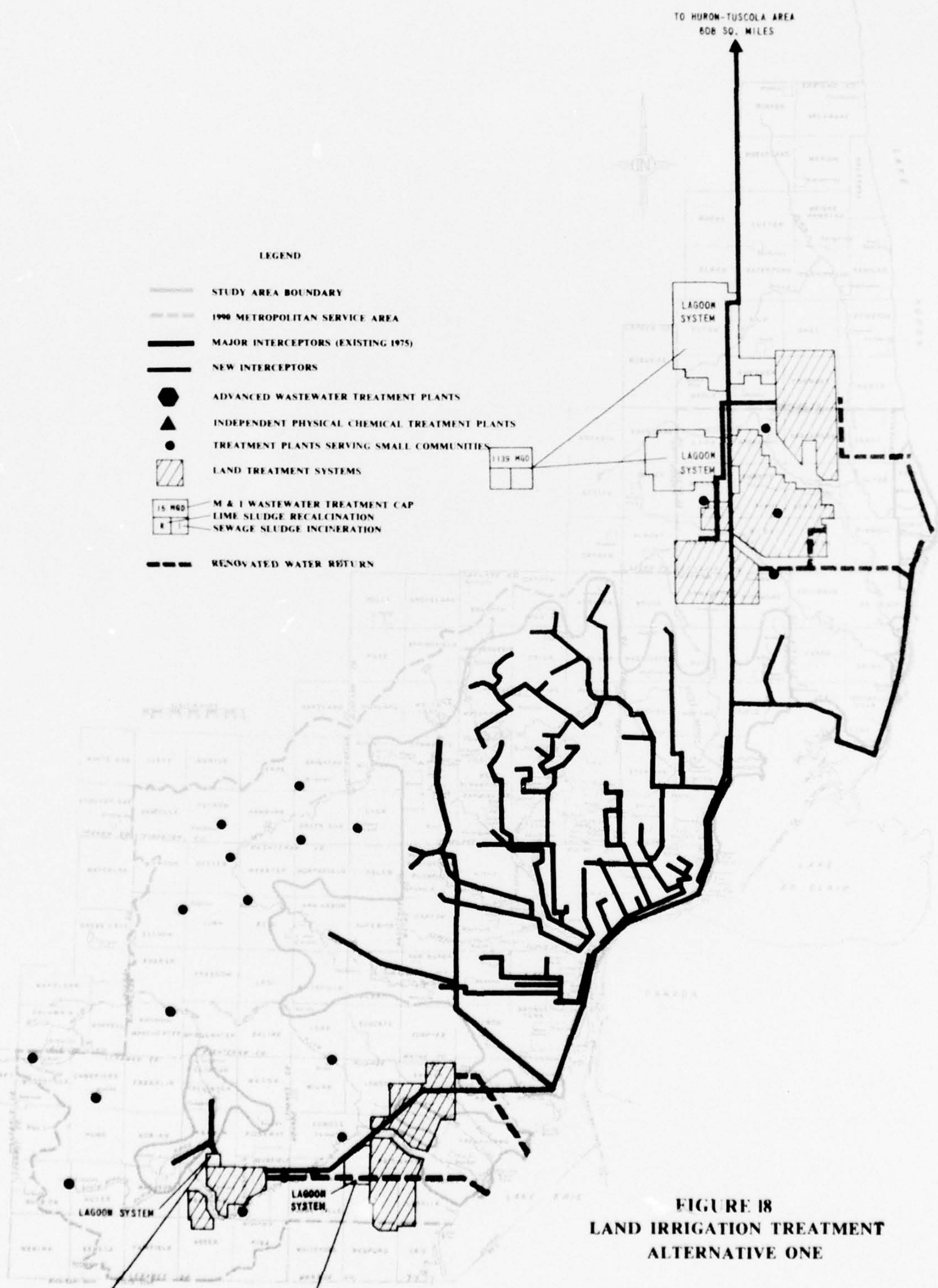

FIGURE 18
LAND IRRIGATION TREATMENT
ALTERNATIVE ONE

Wastewater would be transported to the treatment lagoons from a major transmission tunnel paralleling the Lake St. Clair, the Detroit River, and the Lake Erie shoreline, see Figure 18. Major interceptors, from Ann Arbor along the Huron River and from the Huron River north along Hannan Road, would be required to complete the Detroit regional municipal-industrial interceptor system. A second interceptor system, paralleling the St. Clair River, would serve St. Clair County.

The system for collection and storage of storm runoff would be independent of the municipal-industrial wastewater system until the stormwater system would discharge to the Detroit River transmission tunnel. The stormwater storage system would consist of forty-nine community reservoirs ranging from 80 to 690 acres in size. Two regional reservoirs of 3,120 acres would be located at each end of the Detroit River transmission tunnel, see Figure 19.

Sludges generated at the aerated lagoons would be dredged from settling lagoons and applied to land adjacent to the lagoon site. Sludge from stormwater storage lagoons would be removed dry and landfilled, as this method would be most economical.

Land Irrigation Treatment Alternative Two

This alternative is similar to the other land treatment alternative in that it would use land irrigation treatment as the primary method of municipal-industrial wastewater treatment. The majority of the storm runoff, however, would be treated by the IPCT process. This alternative would make use of the recyclable constituents from those wastewaters having the greatest concentrations of the desirable constituents, and would treat less concentrated wastes in wastewater plants. Less land would be required for irrigation and the variable nature of stormwater flows would be less significant in the planning of wastewater irrigation. The alternative would still result in abandonment of the major existing wastewater treatment facilities.

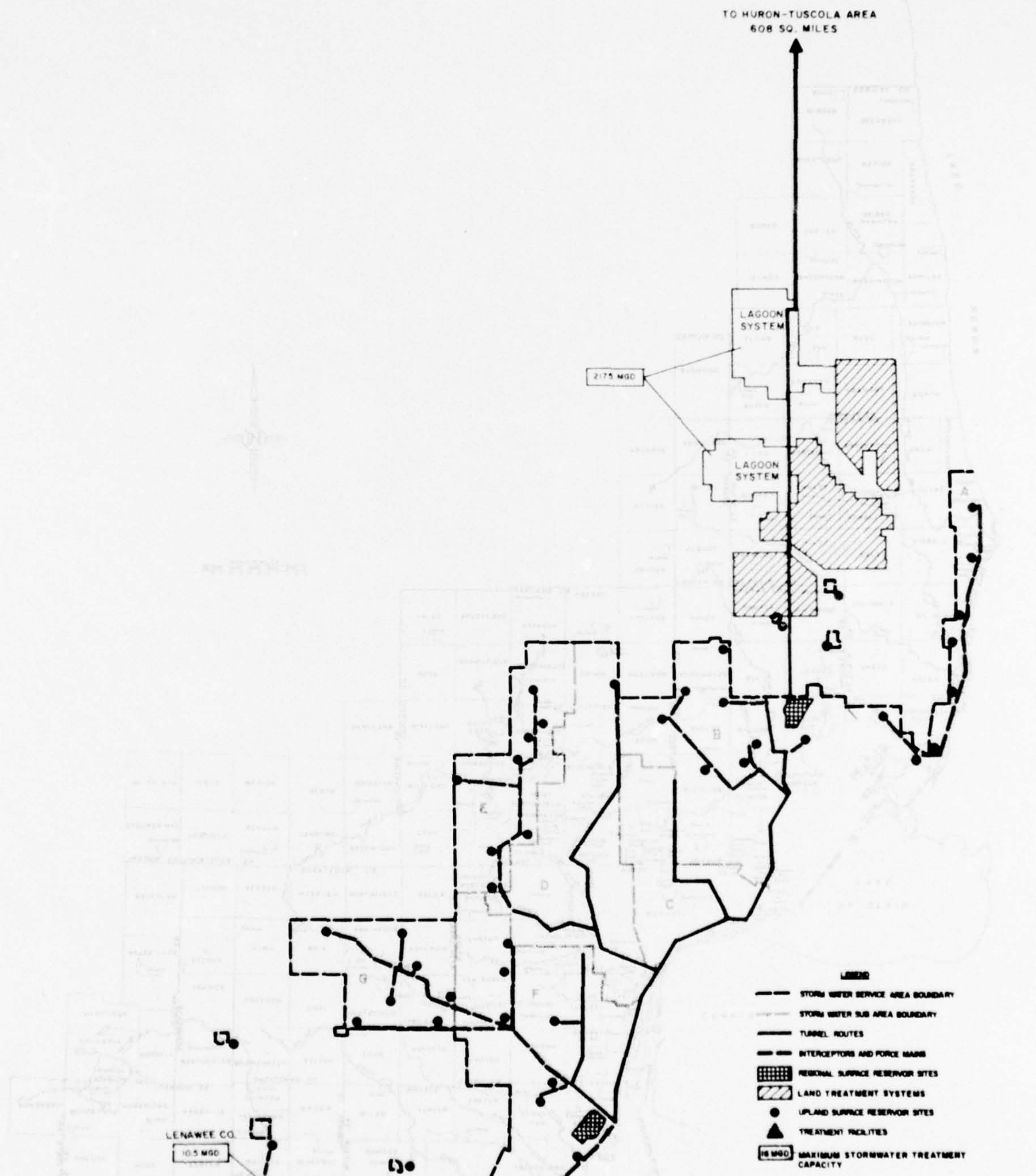

FIGURE 19

STORMWATER CONTROL SYSTEM FOR
LAND IRRIGATION TREATMENT
ALTERNATIVE ONE

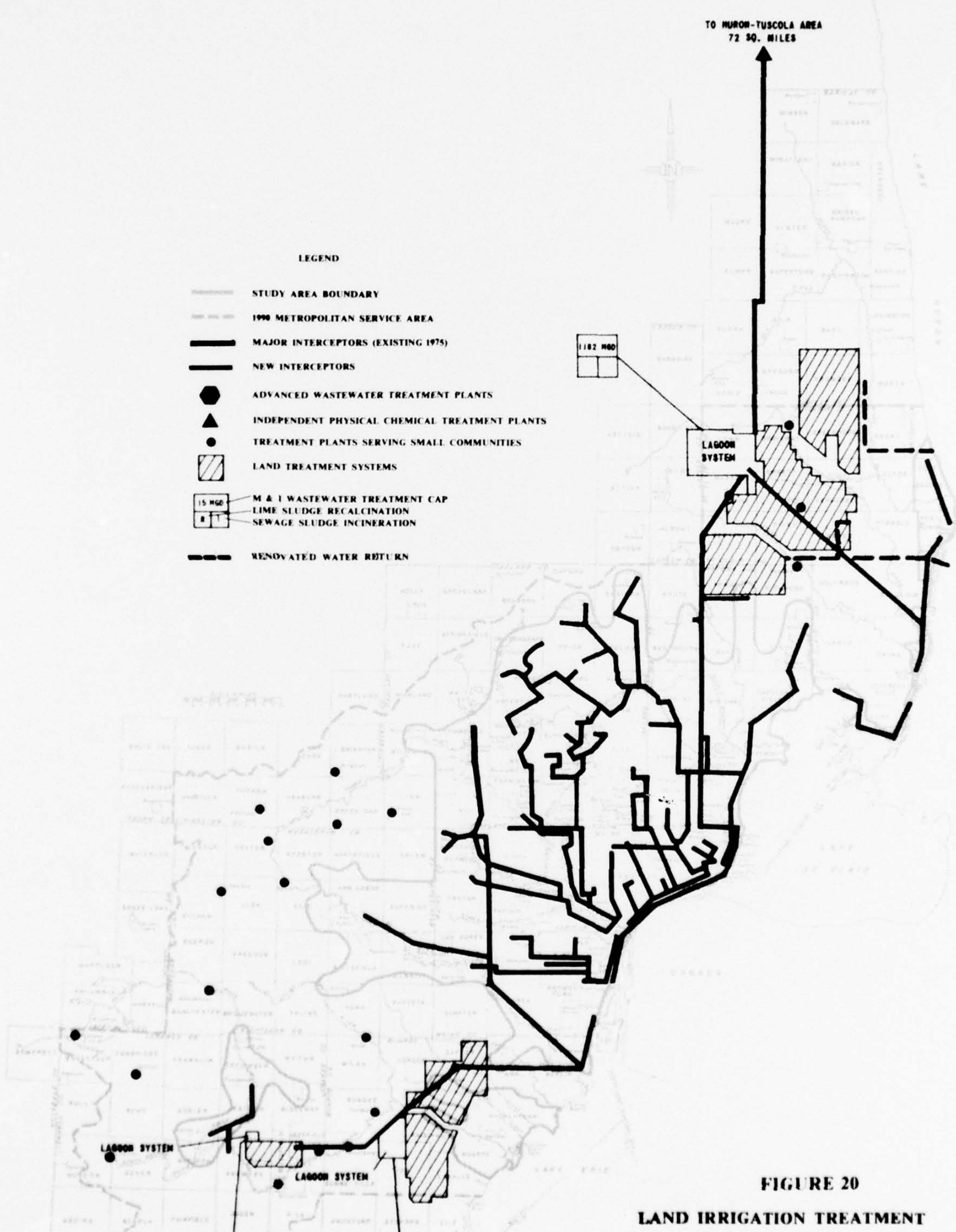

FIGURE 20

LAND IRRIGATION TREATMENT ALTERNATIVE TWO

Municipal-industrial wastewater would be handled as indicated in Land Alternative One; however, since stormwater would be treated in a separate system, the land requirements for treatment and storage lagoons and irrigation are significantly less. The collection and transmission system would change somewhat since storm and municipal-industrial wastewater separation would be maintained, see Figure 20. A major transmission tunnel would be required from the site of the existing Detroit plant, north to the St. Clair County lagoon site. The northern portion of the Hannan Road interceptor system would remain as a part of the Detroit, rather than the Huron River, system. Other interceptors would be as indicated in earlier alternatives.

The storm runoff in this system would be handled at four major IPCT plants as well as two of the land treatment sites. The four plants would be located at Chesterfield Township in Macomb County, Plymouth, south of Ypsilanti and near the mouth of the Huron River, as shown in Figure 21. Storm water from St. Clair County and the Adrian-Tecumseh areas would be handled on adjacent lagoon and irrigation sites. The collection, storage and transmission system would be the same as employed in the other alternatives.

Sludges generated at the aerated lagoons would be dredged from the settling lagoons and applied to adjacent lands. Solids which would accumulate in stormwater storage lagoons would be removed periodically and disposed of in landfill areas in St. Clair and Lenawee Counties. Sludges generated at stormwater treatment plants would be recalcined and lime reused in the process; the ash would be landfilled with solids from stormwater reservoirs.

Combination Wastewater Treatment Alternative One

Combination wastewater treatment alternatives attempt to create the most favorable wastewater management alternatives by combining the most effective wastewater management components for various portions of

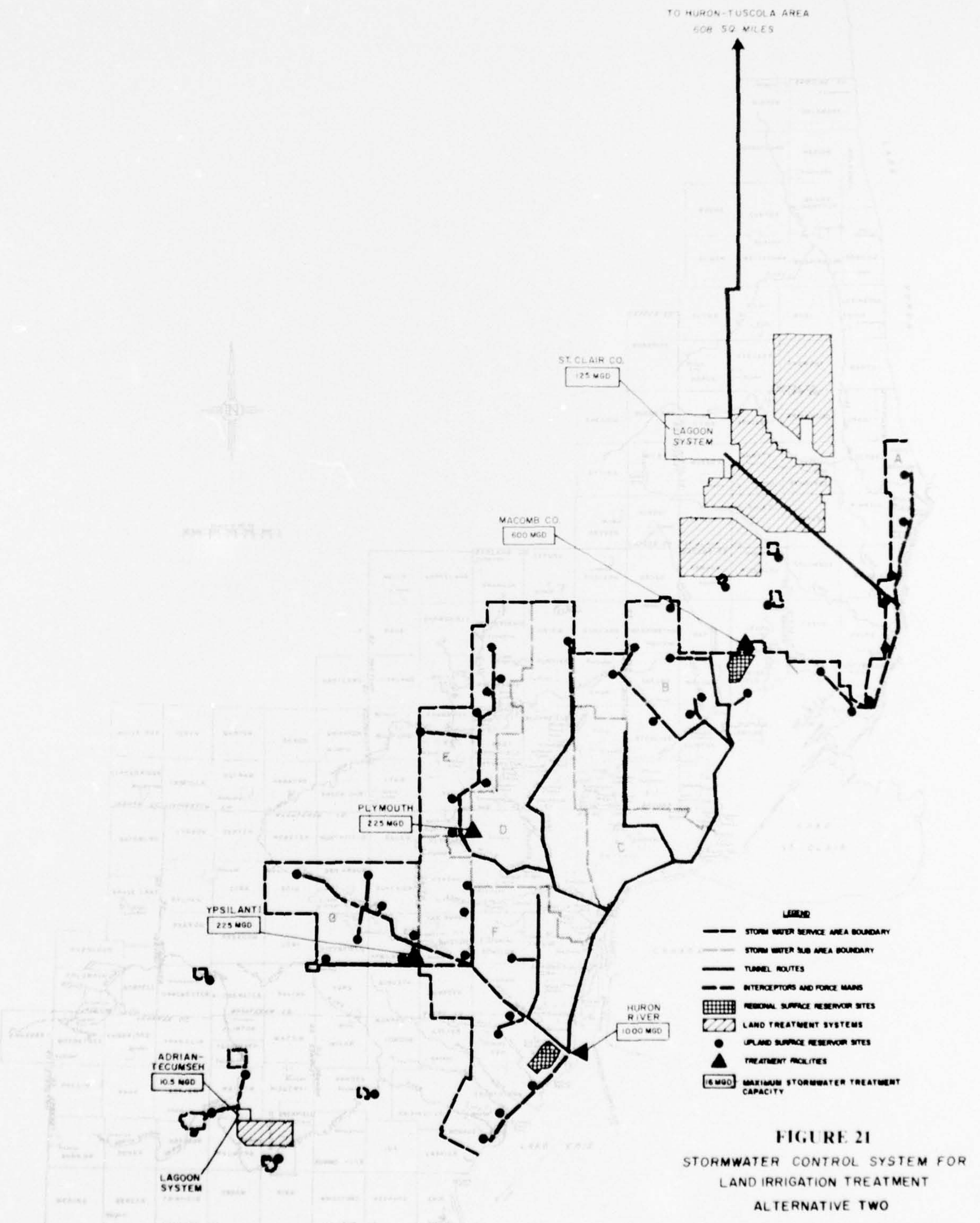

FIGURE 21

STORMWATER CONTROL SYSTEM FOR LAND IRRIGATION TREATMENT ALTERNATIVE TWO

the study area. The first combination alternative proposes conversion to AWT facilities at existing treatment plants, and the use of IPCT facilities where new plants are to be built. Six plants, as shown in Figure 22, would be used to treat municipal-industrial wastewater. Three of these plants would be advanced wastewater treatment facilities created by up-grading existing plants at Port Huron, Detroit and Monroe. The remaining would be new independent physical-chemical treatment plants constructed at East China, the Huron River, and Adrian-Tecumseh.

The stormwater control system would be similar to the one used in the AWT and IPCT alternatives mentioned earlier. It would include a massive system of interceptor sewers and tunnels, storage facilities and treatment at three collocated facilities (East China, Huron River, and Adrian-Tecumseh), and three new separate sites (Plymouth, Ypsilanti and Macomb County).

Sludge handling methods vary from plant to plant. Sewage sludges from the Detroit and Port Huron plants would be dewatered and landfilled. Comparable sludges at the Monroe plant would be incinerated and the ash landfilled. Lime sludges at Adrian-Tecumseh and Port Huron would be landfilled. Lime sludges from all other plants would be recalcined and the lime reused.

Combination Wastewater Treatment Alternative Two

This alternative would also utilize both advanced wastewater and independent physical-chemical treatment methods for renovation of municipal-industrial wastewater and independent physical-chemical treatment for stormwater. With one exception, this alternative duplicates Combination Alternative One. The exception is that wastewater from the area just south of the Detroit service area would be handled at the Wyandotte plant (upgraded to AWT), rather than being conveyed down river to the Huron River

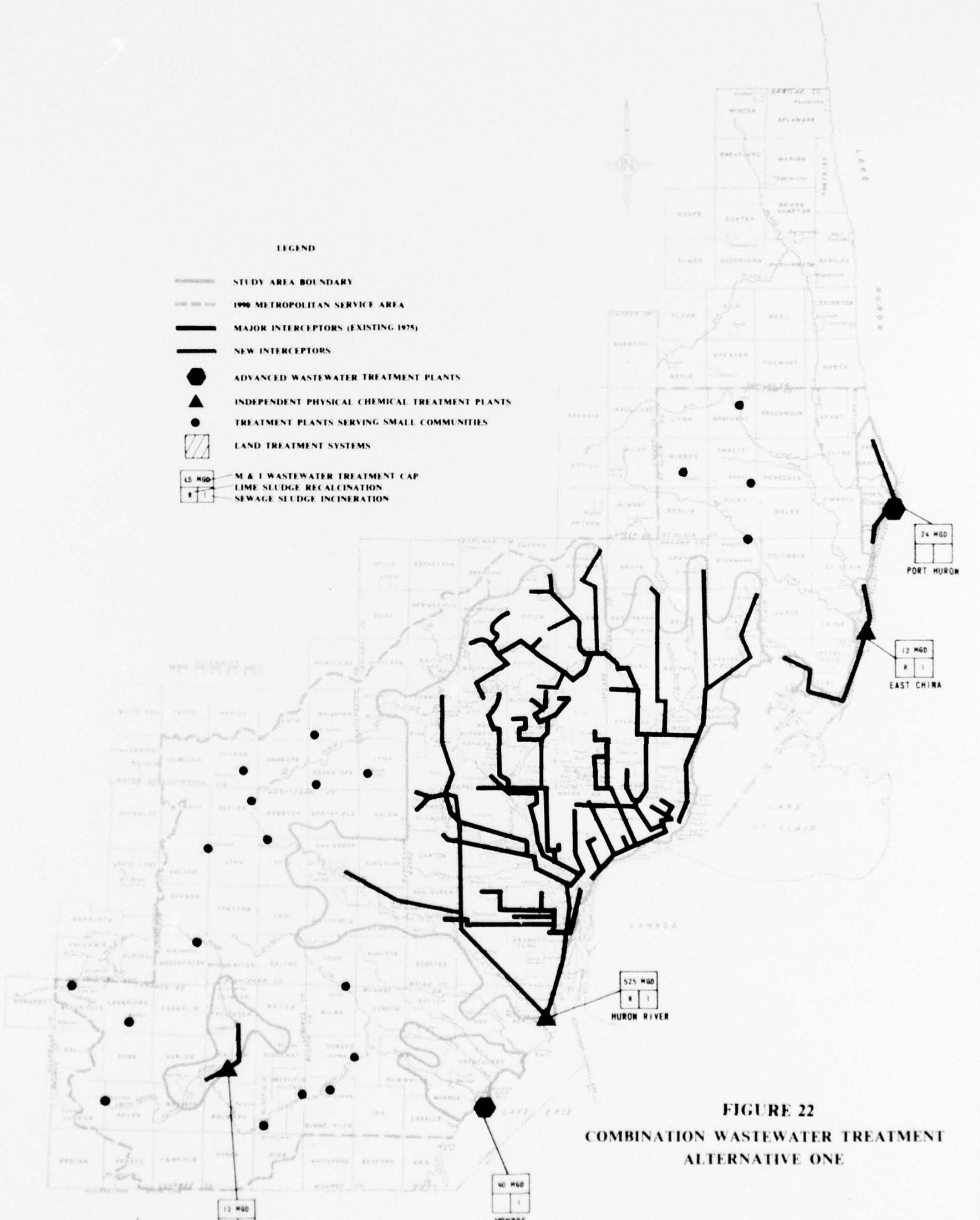

FIGURE 22
COMBINATION WASTEWATER TREATMENT
ALTERNATIVE ONE

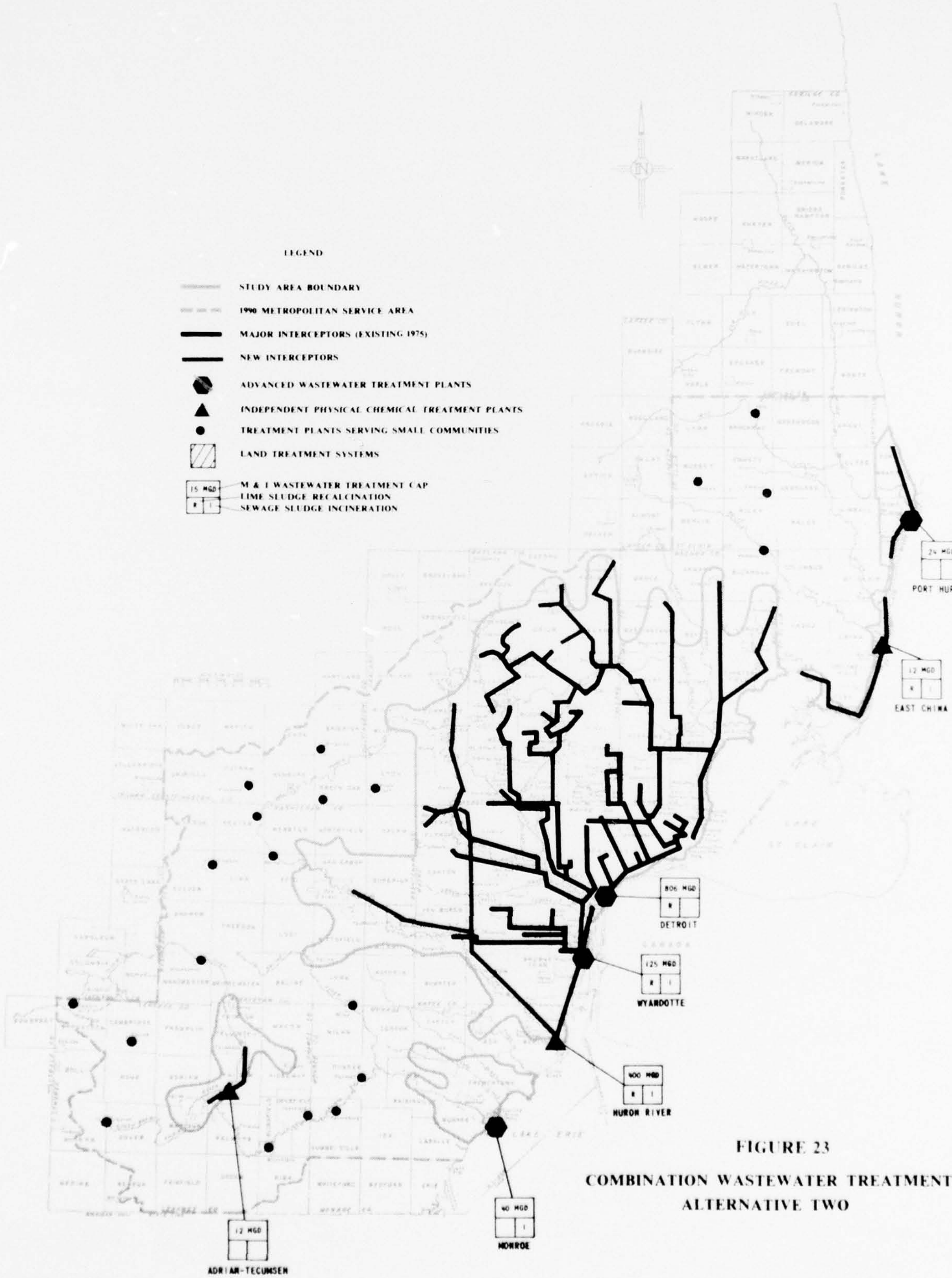

FIGURE 23

COMBINATION WASTEWATER TREATMENT ALTERNATIVE TWO

plant, see Figure 23. The purpose of creating this alternative was to test the viability of maintaining the Wyandotte plant in a regional scheme and to make use of the existing treatment facilities at this location.

Major differences between the alternatives would be: (1) location of a plant at Wyandotte employing both sewage sludge incineration and lime sludge recalcination, (2) reduced size of the downriver interceptor, and (3) reduced size of the Huron River plant.

Combination Wastewater Treatment Alternative Three

This alternative as shown in Figure 24, uses advanced wastewater, independent physical-chemical, and land irrigation treatment methods for renovation of municipal-industrial wastewater. This alternative also uses both independent physical-chemical and land irrigation treatment methods for stormwater renovation. This plan duplicates Combination Alternative Two with the exception that land irrigation treatment would be employed in St. Clair and Lenawee Counties rather than building IPCT plants at East China and Adrian-Tecumseh. This alternative would allow evaluation of land irrigation treatment for less urbanized areas reasonably close to irrigation sites.

Municipal-industrial wastewater would be treated at AWT plants at Port Huron, Detroit, Wyandotte and Monroe, at an IPCT plant near the Huron River, and at the two irrigation sites referred to earlier. The irrigation system would be a totally controlled system; thus, purchase of the land was assumed necessary. The interceptor system would be as described in earlier alternatives (i.e., AWT Alternative One) except that additional transmission lines would be required from the St. Clair River and Adrian-Tecumseh interceptors to the treatment lagoon sites.

The stormwater collection and storage system would be the same as for other alternatives described previously, see Figure 25. Stormwater

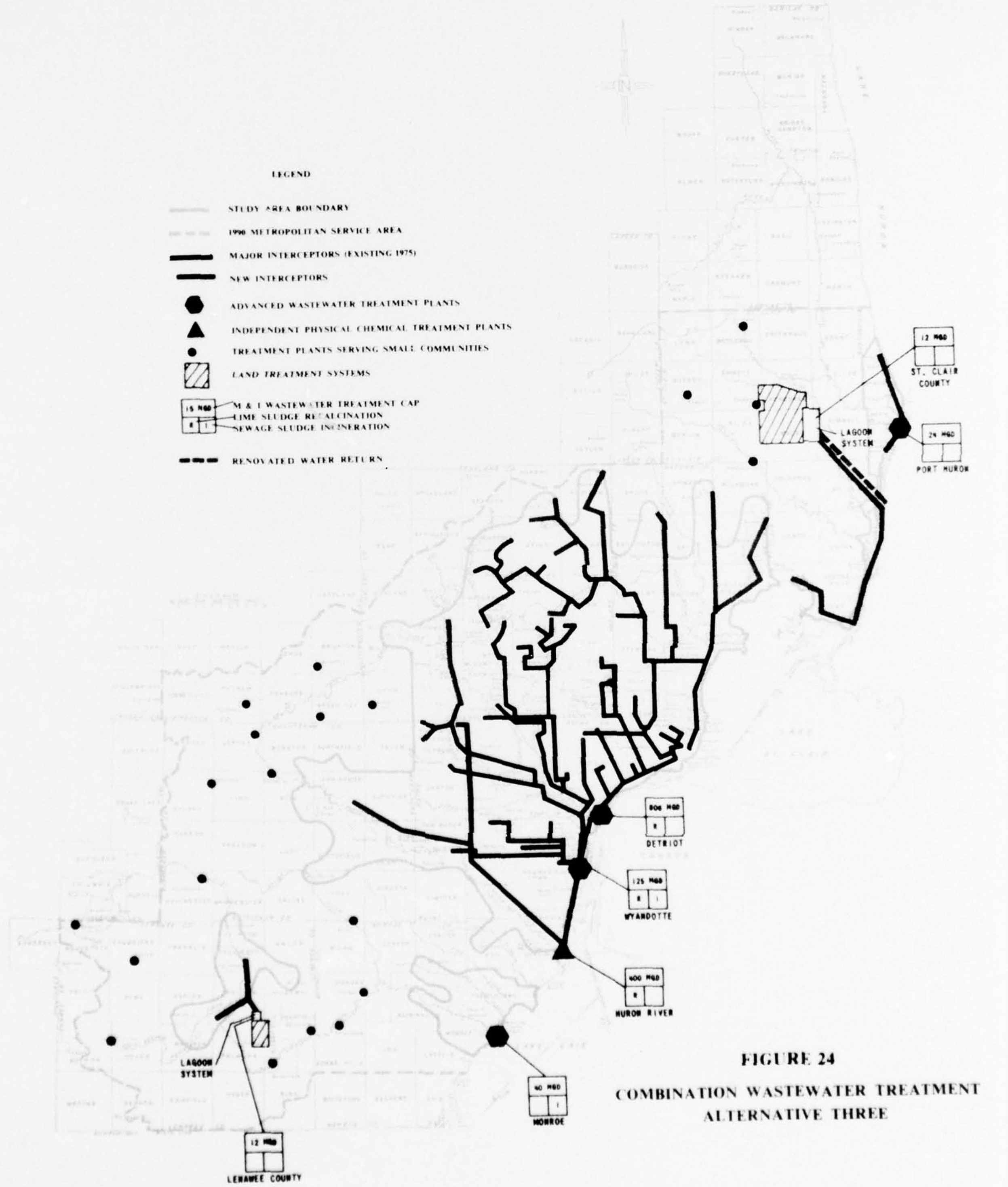

FIGURE 24

COMBINATION WASTEWATER TREATMENT ALTERNATIVE THREE

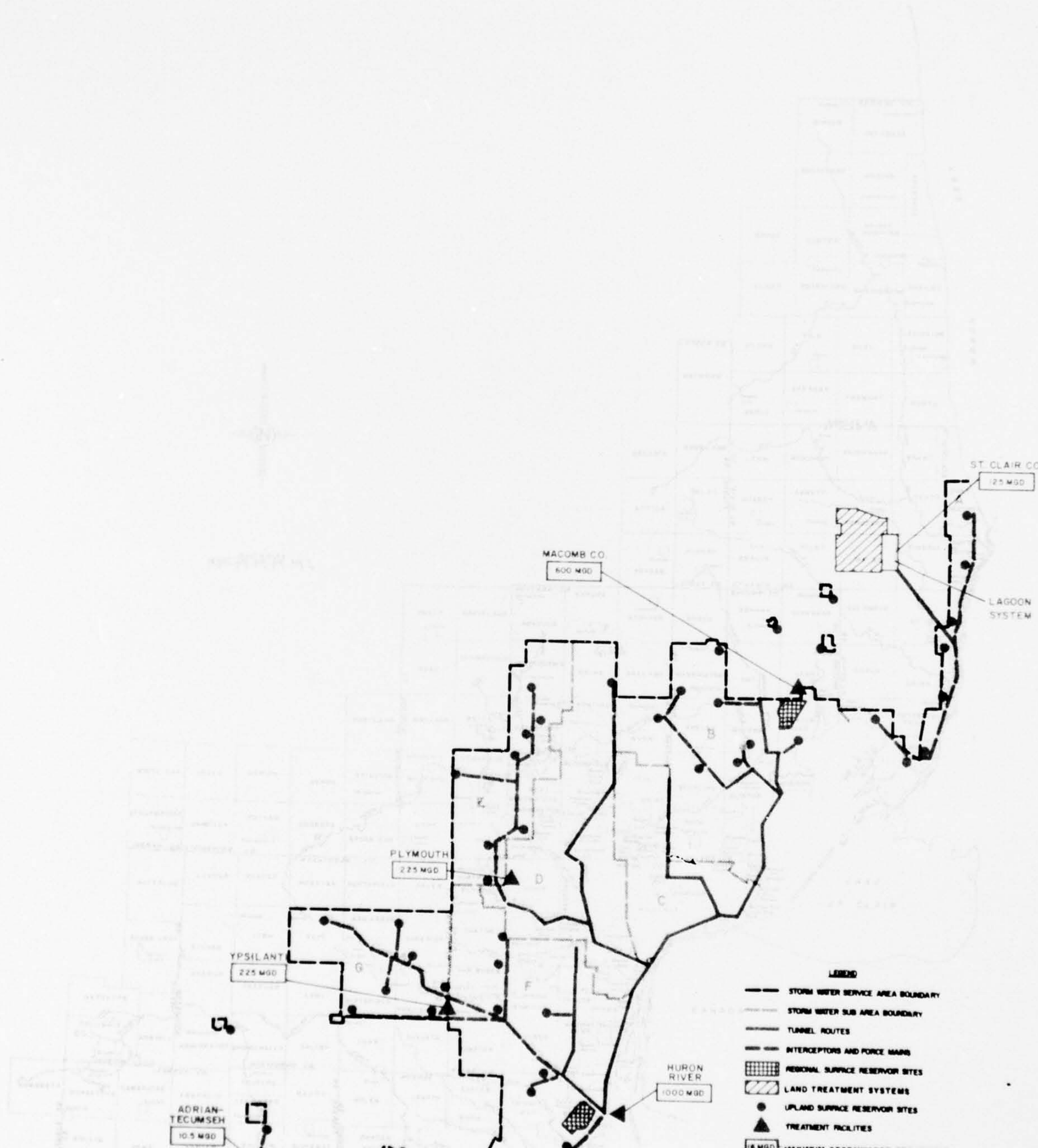

FIGURE 25

STORMWATER CONTROL SYSTEM FOR COMBINATION WASTEWATER TREATMENT ALTERNATIVE THREE

treatment would be provided at IPCT plants located in Chesterfield Township in Macomb County, near the mouth of the Huron River, in Plymouth and south of Ypsilanti. Stormwater collected in St. Clair and Lenawee Counties would flow to the land irrigation systems through the same transmission lines as the municipal-industrial wastewater.

Sludge handling at treatment plants would be the same as described in Combination Alternative Two. Sludge removed from the treatment lagoons in the two land irrigation systems would be applied to the land adjacent to the treatment lagoons.

Combination Wastewater Treatment Alternative Four

This alternative would use advanced wastewater and land irrigation treatment methods for municipal-industrial wastewater renovation and independent physical-chemical and land irrigation treatment methods for stormwater treatment. In this plan, as shown in Figure 26, land irrigation treatment would be utilized in lieu of building any new regional plants for treatment of municipal-industrial wastewater.

Municipal-industrial wastewater treatment plants in Port Huron, Detroit, Wyandotte and Monroe would be maintained and upgraded with AWT processes to make maximum use of existing facilities and minimize loss of treatment effectiveness during implementation. The remainder of the wastewater would be handled at land systems located in St. Clair, Monroe and Lenawee Counties.

Some changes in the regional interceptor system would be required. Wastewater would arrive at the St. Clair County lagoon system through a transmission line from the St. Clair area with wastewater from southern St. Clair County and a transmission line which would intercept the flow from the Oakland-Macomb interceptor system. Flow from the north half of the

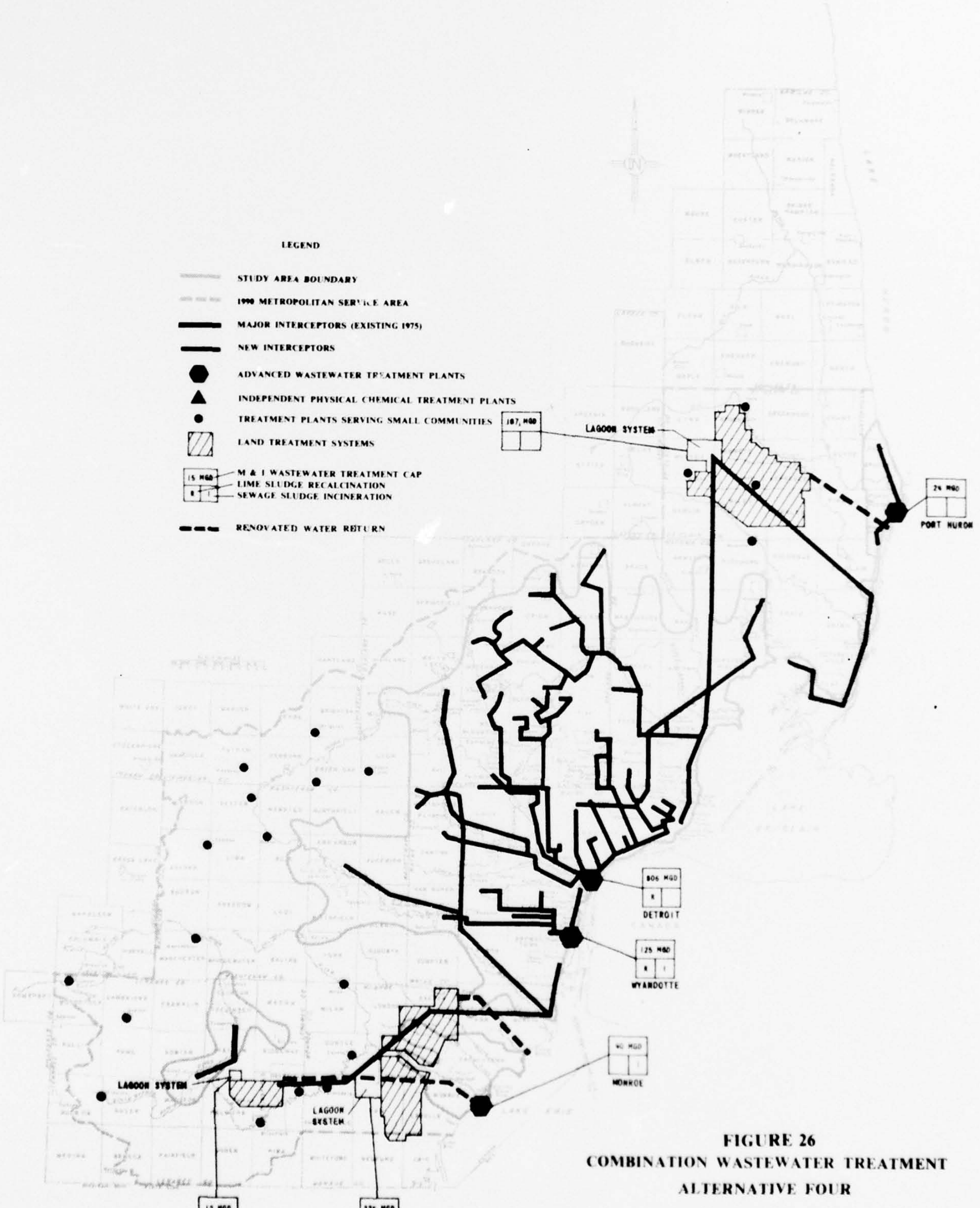

FIGURE 26
COMBINATION WASTEWATER TREATMENT
ALTERNATIVE FOUR

Hannan Road interceptor would flow into the Detroit interceptor system. The wastewater from the Huron River interceptor and the downriver Detroit interceptors would flow to the Monroe County lagoon system for subsequent irrigation on land in Monroe and Lenawee Counties.

The stormwater would be handled in the same manner as described in Combination Alternative Three. Stormwater plants would be located in Chesterfield Township, near the Huron River, in Plymouth, and south of Ypsilanti. The stormwater collected in St. Clair and Lenawee Counties would be handled in nearby land irrigation systems.

Sludges generated in the lagoon treatment sites would be applied to land adjacent to the lagoons. Sewage sludges would be incinerated at the Wyandotte and Monroe sites; and lime sludges would be recalcined at all but the Monroe and Port Huron plants. The remainder of the sludges and the stormwater solids would be disposed of at landfill sites in St. Clair and Lenawee Counties.

Additional Options for Utilizing Land Treatment

Due to the objections expressed to a land treatment system based on the acquisition of the land needed for irrigation, a second land alternative was formed. The objective of this land treatment option was to maximize crop production by use of the soil and natural processes for recycling and containing pollutants and at the same time present significant opportunities for eliminating water borne wastes and improving the productivity of the soil. It is felt that this could best be accomplished if the individual farmer would remain on his property and actively participate in the farming and wastewater renovating processes.

Two systems were investigated using the private ownership concept of land irrigation treatment for all wastewater and urban storm runoff generated in the Southeastern Michigan area. In one alternative, Land Irrigation Treatment Alternative Three, aerated lagoons, as described in previously presented land irrigation plans, would be used to achieve secondary treatment prior to irrigation. The second alternative would make use of existing secondary treatment plants for treatment of municipal-industrial wastewater prior to irrigation. Urban runoff would receive the equivalent of primary treatment at stormwater storage sites prior to final storage and irrigation due to settling.

Land Irrigation Treatment Alternative Three

This alternative as shown in Figure 27 was designed for use of the revised Land irrigation concept for all municipal-industrial wastewater and urban storm runoff from the area. It allows for comparison with Land Irrigation Treatment Alternative One.

The plan would use a wastewater collection and transmission system and a stormwater collection and storage system identical to that designed for Land Alternative One. From the regional storage lagoons in Macomb and Monroe Counties, wastewater would be conveyed to treatment lagoon systems in St. Clair and Monroe Counties. A smaller treatment lagoon system would be located east of Adrian to serve the Adrian-Tecumseh area. From the

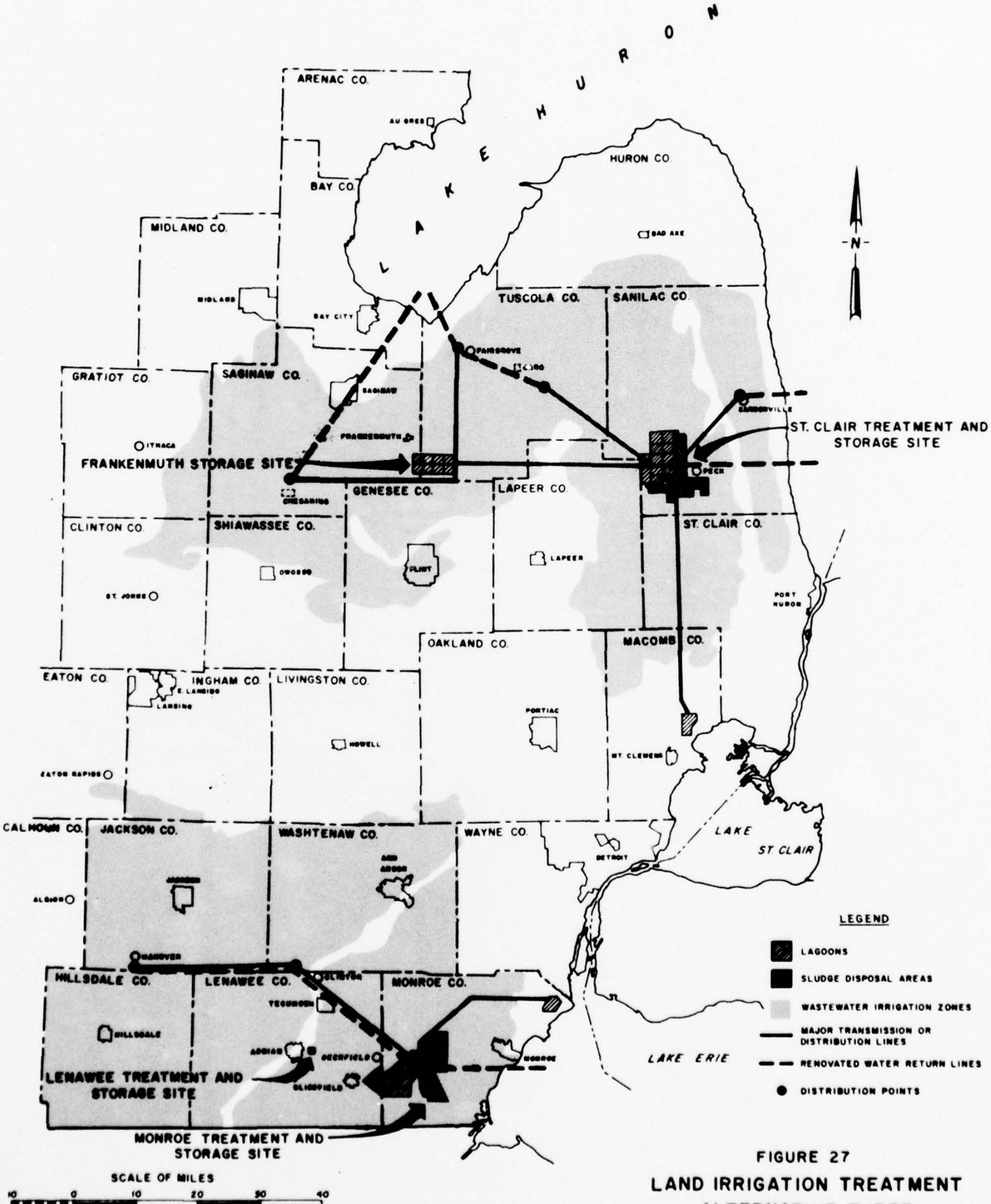

FIGURE 27
LAND IRRIGATION TREATMENT
ALTERNATIVE THREE

treatment lagoons, wastewater would be transferred to storage lagoon systems at the treatment lagoon sites, transferred to a storage site near Frankenmuth or distributed for irrigation. The storage site near Frankenmuth has many advantages. It eliminates the need for aeration lagoons at Frankenmuth and wastewater being transported to Frankenmuth would be secondary effluent rather than raw wastewater. By providing storage at Frankenmuth, the cost of the distribution system would be less since much of it could be designed for lower maximum flow. The 1,616,400 acres of irrigation land would be distributed over a twenty-one county area.

Disinfection procedures would be more stringent since wastewater distribution would be over a wider area and exposure would be increased. Following treatment, ozone would be added to kill most of the bacteria and virus. Prior to distribution to the irrigation areas, sufficient chlorine would be added so as to insure a residual through the distribution system.

Following irrigation, the renovated percolate would be collected in a tile drainage system and returned to a collection point. From the collection point, the renovated water could either be added to local rivers and streams for flow augmentation or transferred to a pipeline capable of returning the total flow to a major water body.

Sludges generated at the lagoon treatment sites would be handled, as in previous land irrigation designs, by application to land adjacent to the lagoons.

Land Irrigation Treatment Using Existing Plants for Pre-Treatment

As previously mentioned, an alternative was considered which would make use of the existing secondary treatment plants in southeastern Michigan rather than building aerated lagoons to perform that function. This would make use of existing facilities and eliminate some of the aesthetic disadvantages of large treatment lagoons. It would also facilitate conveyance of treated wastewater to storage areas rather than raw wastewater.

The development of the plan was not carried out beyong a preliminary stage, since it was primarily intended to allow for the evaluation of the feasibility of such a plan.

EVALUATION OF ALTERNATIVES

During the formation of the eleven alternatives, three alternatives, each employing a single method of treatment, were developed and presented to the evaluators so that evaluation could be carried on simultaneously with the alternative development process. This procedure was used to conserve time and also to facilitate incorporation of information from the evaluation process into the alternative development process.

The information received from the evaluation of these three plans was also useful in identifying both the major impacts which would be associated with implementation of any comprehensive wastewater management plan, and those impacts which would result from extensive use of each of the three methods of wastewater treatment. Thus, the information from the impacts of these three plans was expanded to determine the impact of each of the eleven alternatives.

Ecological, Hygienic, Aesthetic, Social and Economic Effects

Since the primary goals in implementing any wastewater treatment plan are to protect public health and to prevent environmental degradation, a proposed plan must first be evaluated based on its ability to meet those goals. Disinfection procedures used in each of the treatment methods should yield a treated effluent relatively free of harmful pathogens. Other routes of disease transmission must also be considered. Aeorsols from aeration tanks in AWT plants and the aerated lagoons in the land irrigation treatment may spread harmful pathogens considerable distances from the treatment site. Pathogens may also be spread through domestic or game animals and waterfowl which gain access to untreated or partially disinfected wastewater and wastewater sludges. Some areas of concern are: open

lagoons in the land irrigation treatment system, open channels used to distribute only partially disinfected wastewater to irrigation sites, and sludge disposal operations.

A significant improvement in water quality should be realized in streams and rivers in southeastern Michigan. Although the present load of pollutants into Lake Erie would be reduced through implementation of any of these alternatives, this reduction by itself would not significantly improve the eutrophication conditions in Lake Erie. For any major improvements to be realized in Lake Erie it is essential to reduce inputs, including those sources not addressed in the Study, from all watersheds bordering the Lake, not just Michigan. In addition, the existing pollutants in the lake and lake bottom will govern any short or immediate term changes in the eutrophication rate. The land irrigation system was identified as having a higher potential for reducing phosphorus loading than either the AWT or IPCT processes.

Water quality should be improved to the point that total body contact recreation would be allowed in most of the inland streams and rivers, Lake St. Clair, and Lake Erie. The improved water quality should also allow intolerant game fish to survive in the rivers and streams and in Lake Erie if similar wastewater management programs were implemented in other portions of the Lake Erie basin. Any improvement in the Lake Erie fisheries would then depend upon improved management practices in the commercial fishing industry.

A major concern associated with implementation of any of the wastewater management plans would be the excessive demands placed on the construction and equipment supply industries. As can be seen from Table 16, capital costs for the plans range from $4 to $10.5 billion. To meet the 1958 goals of Public Law 92-500, more than $400 million would be expected to be spent annually for construction. Local labor pools would not meet the demand; thus, an immigration of construction workers would be necessary

With similar programs from other areas placing demands on equipment suppliers, meeting construction schedules would be difficult and the additional labor force would also place local demands on housing, utilities and city services.

Another significant impact common to all of the plans would be that residential, commercial, and industrial establishments located on the proposed sites of wastewater facilities would have to relocate. A feeling for the impact of each plan can be gained by referring to the figures in Table 9 which pertain to Land Acquisition. Additional land for treatment plants would have to come from developed urban lands in those cases where an existing plant would require expansion. New plants and stormwater storage sites would be located in less urbanized areas and sites could be selected to minimize impacts. Land required for treatment and storage lagoons in either of the Land Irrigation Treatment Plans would be marginal agricultural land but would require displacement of all residents on 93,000 acres (145 square miles). Impacts would be most significant in the Land Irrigation Treatment Plan (Public Ownership) which would displace residents and commercial establishments from over 700,000 acres (1,100 square miles) of land.

Energy and resource demands are also an important consideration in developing a wastewater management plan. As can be seen from the table below, the IPCT plan would require the least electrical energy but would consume the greatest quantities of fuel and chemicals. The AWT plan requires more power and somewhat smaller quantities of fule and chemicals. The Land Irrigation Treatment Plans, while requiring minimum quantities of fuel and chemicals (some plant nutrients found in wastewater would be recycled) require large quantities of electrical energy. If all chemical and fuel requirements were related to an equivalent electrical power demand (10,000 BTU/KWHR) the demand for each of the plans would be:

TABLE 16

SUMMARY OF SINGLE TREATMENT ALTERNATIVES

	AWT	INPUT	LAND (Emphasis Application)	LAND (Emphasis Crops)
SYSTEM COSTS				
Capital Cost $ billion	4.2-4.3	4.0-4.3	6.0	10.1
Annual Op. & Maint. Cost $ million	110-120	105-120	155	294
Total Annual Cost $ million	370-375	345-375	525	890
OPERATING MANPOWER	3750	2350	1800	2815
PURCHASED LAND (ACRES)				
Stormwater System	23,500	23,500	23,500	23,500
Waste Treatment Facilities	1,400	900	670,000	73,000
Sludge Disposal	3,200-10,500	3,500-15,800	43,500	43,500
PRIVATELY-OWNED FARMLAND	---	---	---	1,616,400
RESOURCE DEMANDS				
Electrical Power Demand				
Avg. (MGD)	320	150-200	1142	660
Peak (MW)	2200	2050	4100	2900
Chemicals (Daily Demand)				
Lime (T/D)	1500-1700	1500-2800	---	---
Methoanol (T/D)	200	---	---	---
Chlorine (T/D)	200	900	180	180
Fuel* MM-BTU	4,000-36,000	7,000-31,000	600	600

*Fuel includes diesel fuel for sludge hauling and either natural gas or fuel for activated carbon regeneration and sludge incineration.

AWT	400-530 MW
IPCT	350-420
Land Irrigation (Public)	1142
Land Irrigation (Private)	1100

Peak power demands for all of the plans could be attributed to the stormwater management system. Auxiliary diesel or gas turbine power plants would be required to provide power on short notice for that system. That auxiliary power generation capability would be a valuable standby power source for the metropolitan area.

In summary, Land Irrigation Treatment on publicly owned land does not appear feasible for the entire Southeastern Michigan area due to excessive social and economic disruption, excessive cost and excessive energy demands. Although both the IPCT and AWT plans have their advantages, the better solution would probably utilize parts of each with possible favorable uses of Land Irrigation Treatment in the less urbanized areas of Lenawee and St. Clair Counties.

The Land Irrigation Treatment plan which would allow private ownership and control of the farming operation, while less socially objectionable, would still require excessive amounts of energy and would have excessive costs.

Chapter 7

FINAL ALTERNATIVES FOR CHOICE

Four plans were selected for further consideration. They include three Representative Plans and an Interim Water Quality Plan. The three representative plans were developed to reflect application of the "best available technology" for wastewater treatment in Southeastern Michigan. They were designed to approach, as nearly as possible, the ultimate goal of Public Law 92-500: to eliminate "the discharge of pollutants into navigable waters" by 1985.

The Interim Water Quality Plan has been derived from the State of Michigan's water quality plan. It is presented as an Interim Plan because depending on the interpretation of Public Law 92-500, this plan could satisfy, the 1983 requirement of "best practicable technology."

Interim Water Quality Plan

The Interim Water Quality Plan should be capable of achieving "wherever attainable . . . a water quality which provides for the protection and propagation of fish, shellfish, and wildlife and provide for recreation in and on the water." Most of the information used in the development process came from the Water Resources Commission Phase II Plan for Southeastern Michigan.

In this plan, 46 wastewater treatment plants in the area would provide treatment of municipal and industrial wastewater, and overflow from the combined sewers. Three regional plants located in Detroit, Wyandotte and at the Huron River would have a total design-treatment capacity of 1420 million gallons per day (MGD). Forty-three minor plants having a total design capacity of 160 MGD would serve communities that are not a part of a regional system (see Table 17). Plant locations can be seen on Figure 28. Many of the minor plants are considered interim facilities to provide treatment until growth of the community would justify further extension of the regional interceptor system.

TABLE 17

INTERIM WATER QUALITY PLAN

	Design Treatment Capacity (MGD)	Sludge Disposal Method*	Additional Land Required (Acres)	Capital Cost $Million	Annual O&M Cost $Million	Total Annual Cost $Million
Major Wastewater Plants						
Detroit	1200	INC	50	162	13.4	23.0
Huron River	121	INC	42	36	1.7	3.8
Wyandotte	100	INC	17	--	1.4	1.4
Minor Wastewater Plants						
Warren	36	INC	--	--	0.5	0.5
Pontiac	30	INC	7	9	0.6	1.1
Monroe	24	INC	--	--	0.4	0.4
Port Huron	20	INC	5	--	0.4	0.4
Algonac	8.3	LF	7	5	0.2	0.5
Adrian	7.5	LF	3	1	0.2	0.3
Trenton	5.5	INC	--	2	0.2	0.3
Others				44	1.0	3.6
Wastewater Interceptors and Transmission Lines				435	--	25.7
Combined Sewer Relief System				1,495	3.5	91.8
Sludge Landfills			650	(Costs included in plant costs)		
SYSTEM TOTALS	1554		781	2,270	20.0	152.8

*INC: sludge incineration; LF: sanitary landfill of sludge

FIGURE 28

INTERIM WATER QUALITY PLAN

MUNICIPAL, INDUSTRIAL & COMBINED SEWER OVERFLOW WASTEWATER

The degree of treatment required at a particular plant depends upon the water body into which the plant discharges. Plants which discharge directly to the Saint Clair River, the Detroit River, or Lake Erie would be required to provide an equivalent of secondary treatment and remove a minimum of 80 percent of the phosphorus. Plants discharging to inland streams would be required to provide a higher degree of treatment as shown in Table 18 below.

Table 18

EFFLUENT REQUIREMENTS

FOR PLANTS DISCHARGING TO INLAND STREAMS

5 - Day BOD	4.0 mg/l
Ammonia Nitrogen	0.5 mg/l
20 - Day BOD	8.0 mg/l
DO in the effluent	5.0 mg/l minimum
Total Phosphorus Removal	80% minimum
Suspended Solids	15.0 mg/l
Fecal Coliform	100/100 ml
Total Coliform	1000/100 ml

Additional interceptors will be required to provide transportation of wastewater being generated from the newly developed portions of the 1990 service area. The Detroit collection system would be expanded to serve developing portions of Macomb and Oakland Counties. Additional interceptors would also be built to relieve overloaded portions of the existing combined sewer system most prevalent in older portions of the service area. The collection system which terminates at the Wyandotte plant would remain unchanged since it is not expected to expand and the area it serves is already developed to a large degree. The collection system which would lead to the proposed Huron River Plant would have to be constructed in its entirety. This sewerage system would serve a major portion of the new development in Southeastern Michigan.

Sewage sludges in all but two of the plants would be incinerated. Incineration is primarily for volume reduction-and stabilization before final disposal in a landfill. The relatively limited availability of landfills near the large urban plants has made this method feasible.

The two plants which would not have incinerators, Algonac and Adrian, would dewater the sludge and landfill it. These plants are fortunate to be in locations where landfill sites are available and are within economic haul distance from the plant. The quantity of sludge produced at these two plants is also small enough that the quantities are not a limiting factor.

The combined sewered systems of Southeastern Michigan contribute a significant pollutant load to the surface waters of the area through by-passes and overflows. To meet the water quality goals of the region, three plans were developed for controlling the combined sewer overflows and thus limiting the total pollutants discharged to a receiving stream. In each plan, a specified volume of combined sewer overflows would be stored in numerous facilities constructed throughout the area. These facilities would provide for the retention of floating debris by skimming, chlorination for effective disinfection of the overflows which would occur when the storage capacity is exceeded, and the removal of septic solids buildup deposited by smaller retained storms over an extended period. From storage, the retained stormwater would be reintroduced into the interceptor system at a lower rate and treated at the same facility used to treat the municipal-industrial flow from the area. The most extensive storage system was selected since the other two plans would probably not be sufficient to meet the interim water quality goals. The location and type of storage are not shown on the figure as they have not yet been defined.

Representative Plans

The design and evaluation work described in the previous chapter led to the final selection of representative plans. The evaluation of the original and second stage alternatives on the basis of technical, economical, institutional, aesthetic, ecological, and social considerations resulted in

changes to improve the overall acceptance of the most favorable of these alternatives.

The three representative alternative plans differ in the method of treatment employed in the Adrian-Tecumseh area and in the southern portion of St. Clair County while much of the other facilities are the same. Thus, the representative plans could be considered as one plan with three variations or sub-systems. Common to each representative plan is the use of three existing wastewater treatment plants located in Detroit (W. Jefferson Avenue), Wyandotte, and Monroe. These plants would be upgraded to advanced wastewater treatment plants to make use of the existing facilities, especially those which have just been added or are currently under construction. The existing wastewater treatment plant in Port Huron would be converted to an independent physical-chemical treatment plant because the additional land required for adding advanced wastewater processes to the existing secondary facilities would not be easily acquired. A new plant at the Huron River would also be common to all plans. This plan would be an independent physical-chemical facility because it is the most cost effective method of providing treatment for that area.

All treatment facilities have been designed to meet a minimum effluent standard of:

BOD	4 mg/l
COD	10 mg/l
Suspended Solids	2 mg/l
Total Phosphorus	0.1 mg/l
Ammonia Nitrogen	0.3 mg/l
Total Nitrogen	3.0 mg/l

In addition most heavy metals, synthetic organic chemicals and pesticides would be reduced to trace levels; and the effluent would be relatively free of pathogens.

Most of the interceptor sewer system necessary for this plan will already be in place by 1985. The additional major interceptor construction necessary for implementation of this plan would include: an interceptor along the shoreline in southern St. Clair County to the East China plant, an interceptor along the Detroit River to the Huron River plant, an interceptor from Ann Arbor following the Huron-River to its mouth and an interceptor following Hannan Road north of the Huron River.

The system designed for handling combined sewer overflow and urban storm runoff would be essentially independent of the municipal-industrial wastewater treatment system. The stormwater system would utilize forty-nine community storage reservoirs ranging in size from 80 to 690 acres. These and two regional reservoirs of 3120 acres each would be used for temporary storage of peak storm flows. Four stormwater treatment facilities would also be common to all plans. They would be independent physical-chemical treatment facilities because advanced wastewater treatment for stormwater cannot be operated in a manner that responds satisfactorily to the intermittant nature of stormwater flows. One of these plants would be constructed as part of regional facilities at the Huron River because similar treatment processes make it economically advantageous and more efficient to integrate portions of the separate treatment facilities. Another plant would be located at the regional storage reservoir in Macomb County for most efficient operation. The remaining stormwater plants would be independent facilities located near Plymouth and Ypsilanti. These plants would discharge a treated stormwater effluent which would have normally been a part of the natural flow of the river. The discharge rate would be more uniform, however, and the quality much higher.

An extensive system of interceptors and tunnels would be required to collect storm runoff and combined sewer overflows at the present points of discharge to surface waters. Normal sewer construction techniques would be utilized in less urbanized areas; however, the greater size of sewers required in highly urbanized areas and the construction problems encountered made design of hard rock tunnels necessary.

Sludges generated at the common wastewater treatment plants would be incinerated in order to reduce the amount of land required for filling the

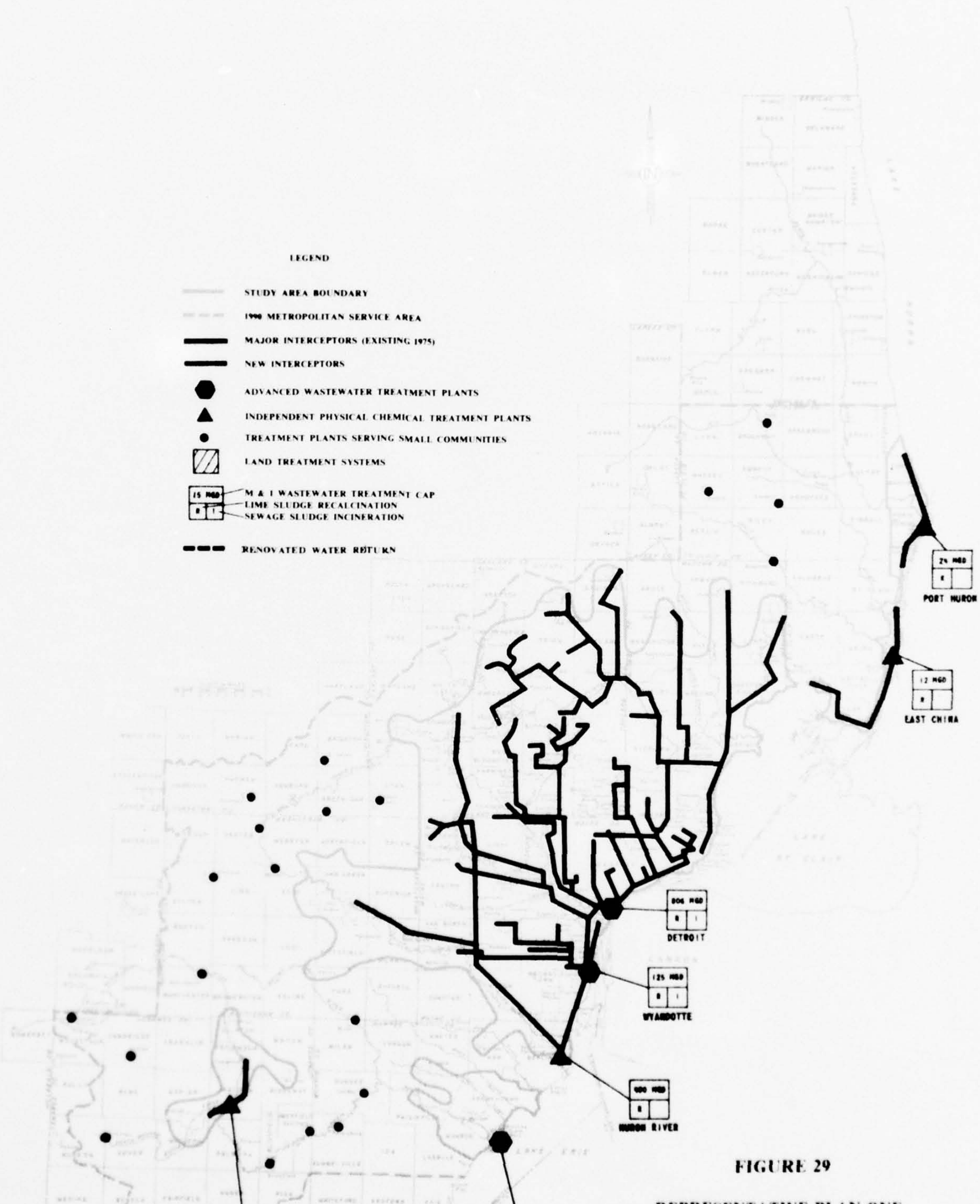

FIGURE 29

REPRESENTATIVE PLAN ONE

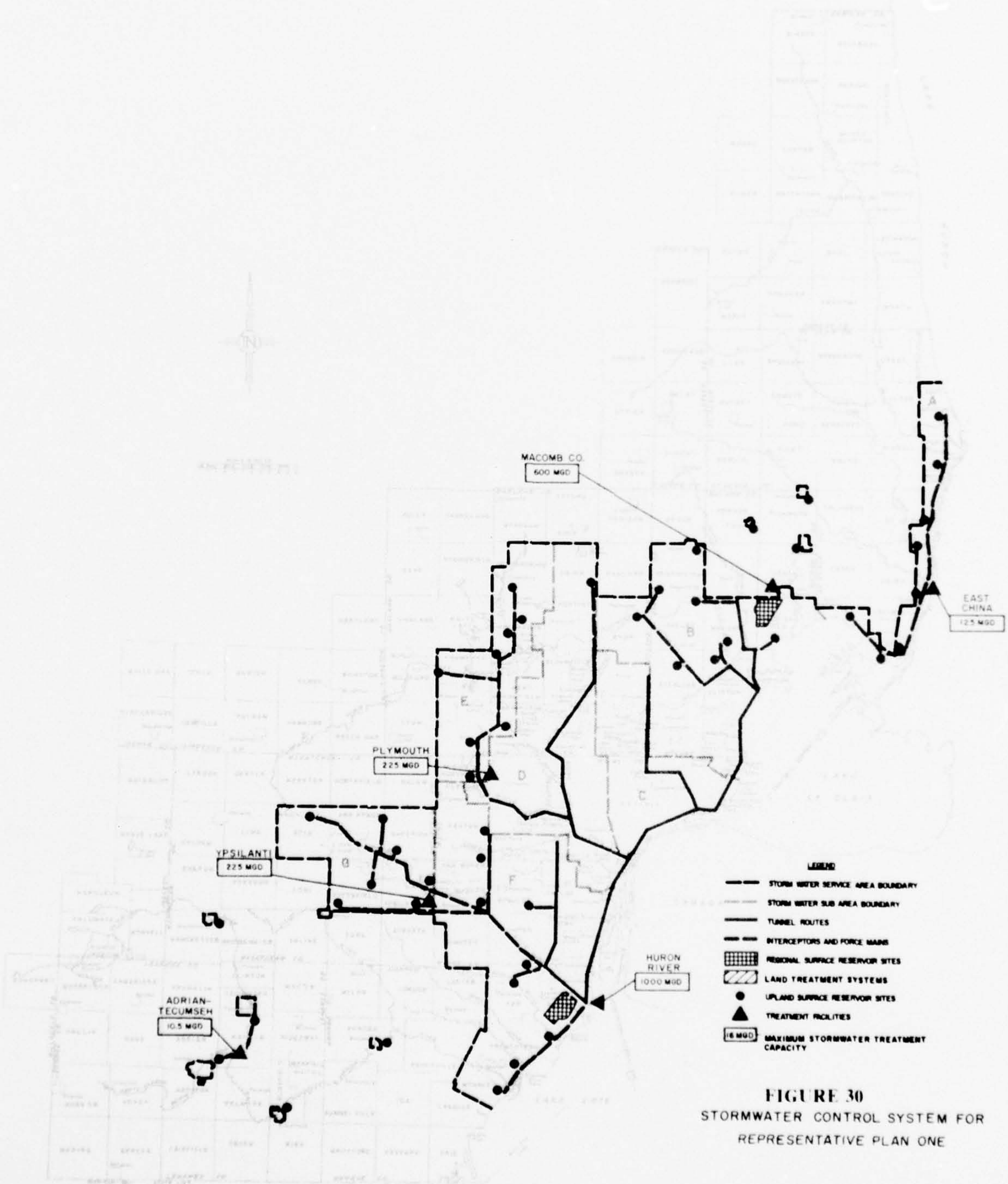

FIGURE 30
STORMWATER CONTROL SYSTEM FOR
REPRESENTATIVE PLAN ONE

TABLE 19

REPRESENTATIVE PLAN ONE

	Facility Capacity (MGD) and Type Mun-Ind	Storm	Sludge Disposal Method*	Land Required (Acres)	Capital Cost $Million	Annual O&M Cost $Million	Total Annual Cost $Million
Wastewater Treatment Plants							
Port Huron	24 IPCT	--	REC,LF	--	10.9	1.5	2.3
Detroit	806 AWT	--	INC,REC,LF	320	385.3	42.6	66.2
Wyandotte	125 AWT	--	INC,REC,LF	100	68.1	8.2	12.4
Monroe	40 AWT	--	INC,LF	50	33.3	3.1	5.1
Huron River	400 IPCT	1000 IPCT	REC,LF	350	493.3	35.1	66.0
Macomb County	--	600 IPCT	REC,LF	160	181.5	8.3	19.2
Plymouth	--	225 IPCT	REC,LF	85	73.8	3.3	7.8
Ypsilanti	--	225 IPCT	REC,LF	85	73.8	3.3	7.8
East China	12 IPCT	125 IPCT	REC,LF	80	57.8	3.0	6.6
Adrian-Tecumseh	12 IPCT	10.5 IPCT	REC,LF	20	11.3	0.8	1.6
Wastewater Interceptors and Transmission Lines					214.6	0.9	13.5
Stormwater Collection, Storage and Transmission			LF	23,500	256.6	6.4	157.7
Landfill Sites							
St. Clair Co.				1,141	6.5	1.1	1.6
Lenawee Co.				2,402	11.7	2.0	2.8
SYSTEM TOTALS	1,419	2,185.5		28,073	4,183.5	119.6	370.6

*REC: Recalcination of Lime sludge; LF: Landfill; INC: Incineration

sludge and to reduce hygienic hazards from handling the sludge. All sludges from lime clarification processes would be recalcined both to reclaim the lime and to reduce the volume of waste sludge. The solids which would accumulate in stormwater storage lagoons would be removed periodically and disposed of in a landfill.

Representative Plan 1

Representative Plan 1, shown in figures 29 & 30 emphasizes wastewater treatment by plants on a regional scale. In addition to the facilities common to each plan, small communities outside the regional service area would operate individual treatment plants until growth might warrant extension of regional interceptors.

The regional service areas in Lenawee County and south Saint Clair County would be serviced by independent physical-chemical treatment plants east of Adrian and at East China Township. The IPCT process would be the most economical type of treatment at these locations. The stormwater treatment plants for these areas would be collocated IPCT plants at these sites for economy and efficiency. A summary of the features of this alternative is in Table 19.

Representative Plan 2

Representative Plan 2, as shown in figure 31 & 32, has both land irrigation and treatment plants in portions of the plan. Land irrigation techniques would be used in central Lenawee and southern Saint Clair County for treatment of both stormwater and municipal-industrial wastewater from these areas. In each system the wastewater would be treated in aerated lagoons, disinfected, then irrigated on farmlands owned and managed by the operating agency. Sludge from the Saint Clair and Lenawee County treatment lagoons would be applied to the land on adjacent sludge disposal sites.

The major portion of the region's wastewater would be treated by the common system described earlier in this section. Small communities outside of the regional service area would operate individual treatment plants until growth would warrant extension of the regional interceptors. A summary of the features of this alternative is in Table 20.

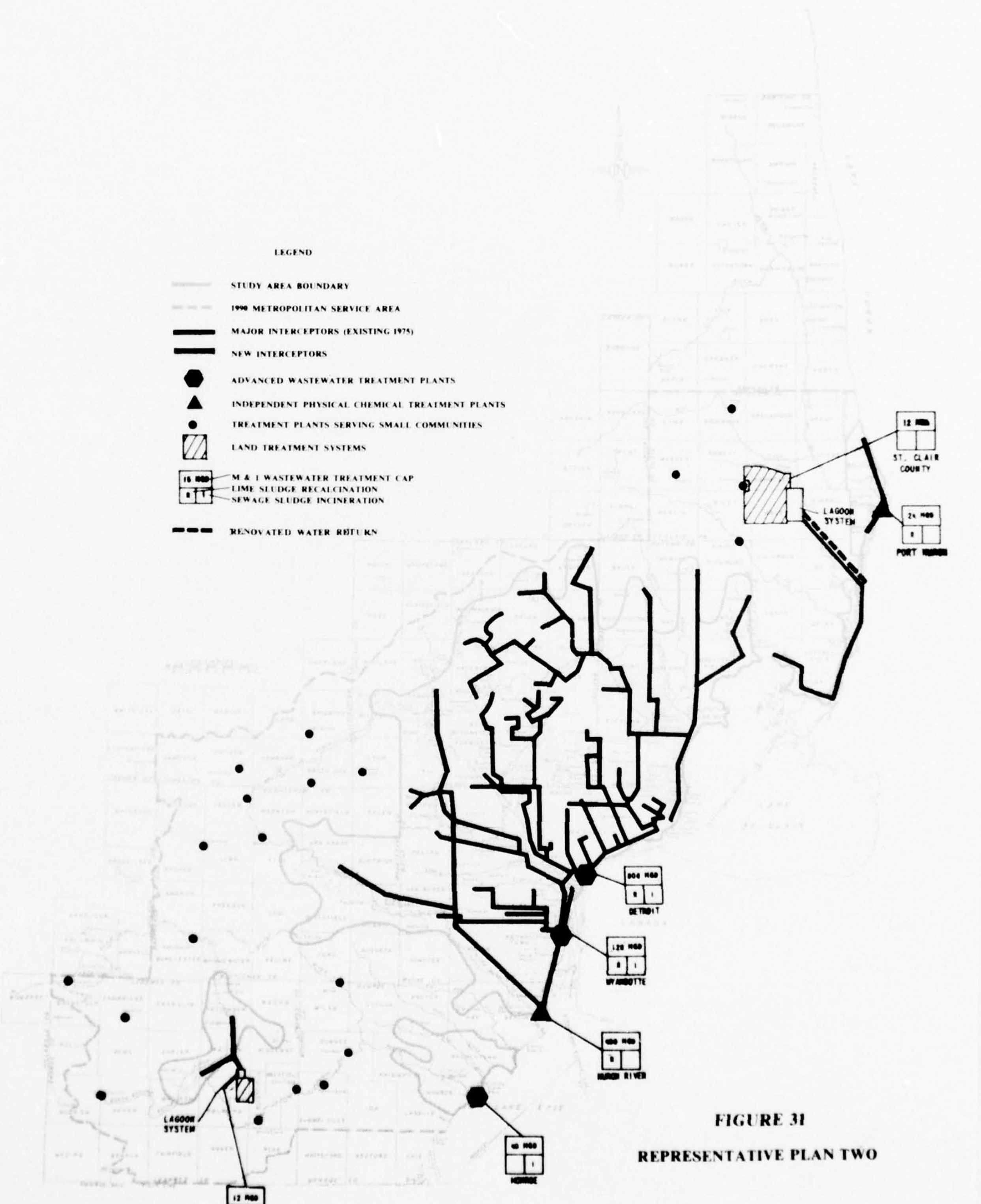

FIGURE 31

REPRESENTATIVE PLAN TWO

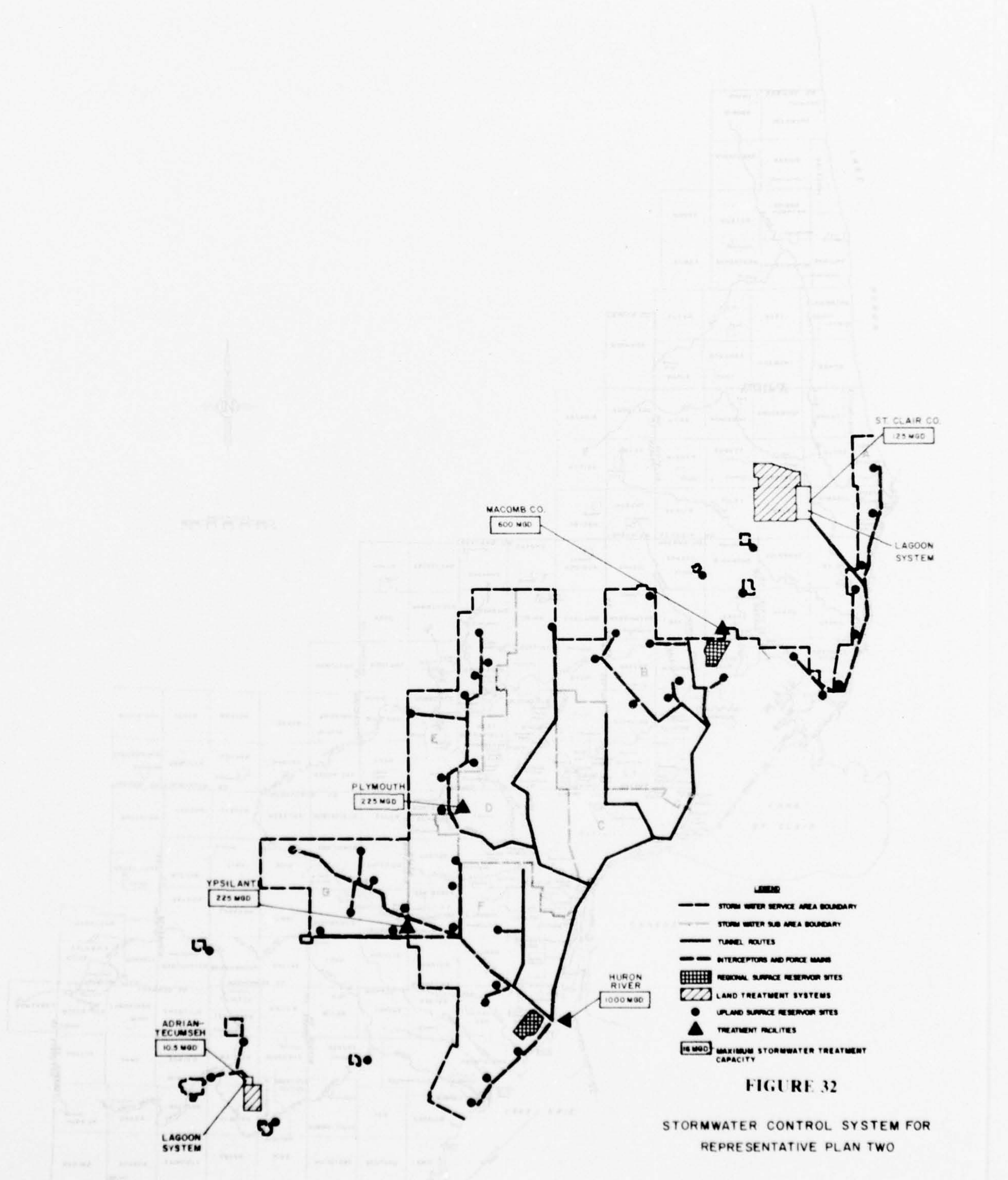

FIGURE 32

STORMWATER CONTROL SYSTEM FOR REPRESENTATIVE PLAN TWO

TABLE 20

REPRESENTATIVE PLAN TWO

	Facility Capacity (MGD) and Type		Sludge Disposal Method*	Land Required (Acres)	Capital Cost $Million	Annual O&M Cost $Million	Total Annual Cost $Million
	Mun-Ind	Storm					
Wastewater Treatment Plants							
Port Huron	24 IPCT	--	REC,LF	--	10.9	1.5	2.2
Detroit	806 AWT	--	INC,REC,LF	320	385.3	42.6	66.2
Wyandotte	125 AWT	--	INC,REC,LF	100	68.1	8.2	12.4
Monroe	40 AWT	--	INC,LF	50	33.3	3.1	5.2
Huron River	400 IPCT	1000 IPCT	REC,LF	350	493.3	35.1	66.0
Macomb Co.	--	600 IPCT	REC,LF	160	181.5	8.3	19.2
Plymouth	--	225 IPCT	REC,LF	85	73.8	3.3	7.8
Ypsilanti	--	225 IPCT	REC,LF	85	73.8	3.3	7.8
Land Treatment Systems							
St. Clair Co. Lagoons, Sludge Disposal, Irrigation and Drainage	12 LAND	125 LAND	LA	22,356	70.3	3.1	7.2
Lenawee Co. Lagoons, Sludge Disposal, Irrigation and Drainage	12 LAND	10.5 LAND	LA	4,775	23.4	0.7	2.1
Wastewater Interceptors and Transmission Lines					264.1	1.6	17.4
Stormwater Collection, Storage and Transmission			LF	23,500	2,561.6	6.4	157.7
Landfill Sites							
St. Clair Co.				1,073	6.2	1.1	1.5
Lenawee Co.				2.338	11.3	1.9	2.7
SYSTEMS TOTALS	1,419	2,185.5		55,192	4,256.9	120.2	375.6

*REC: Recalcination of lime sludge; LF: Landfill; INC: Incineration;
LA: Land application

Capital cost ammortization and total annual costs are based on 5.5% interest over 50 years.

Representative Plan 3

In Representative Plan 3, as shown in figures 33 & 34, the major portion of the region's wastewater would be treated in the plant system common to all plans. Land irrigation treatment would be employed for treating both municipal-industrial and stormwater in southern Saint Clair County and central Lenawee County. In each system the wastewater would be treated in aerated lagoons, disinfected, and distributed to nearby farmers for irrigation on their land. This land would remain under the ownership and control of the individual farmer or land owner. Sludge from the treatment lagoons in Saint Clair and Lenawee Counties would be applied to special sludge disposal sites adjacent to the lagoons. Small communities outside of the regional service area would operate individual treatment plants until growth would warrant extension of the regional interceptors. A summary of the features of this alternative is in Table 21.

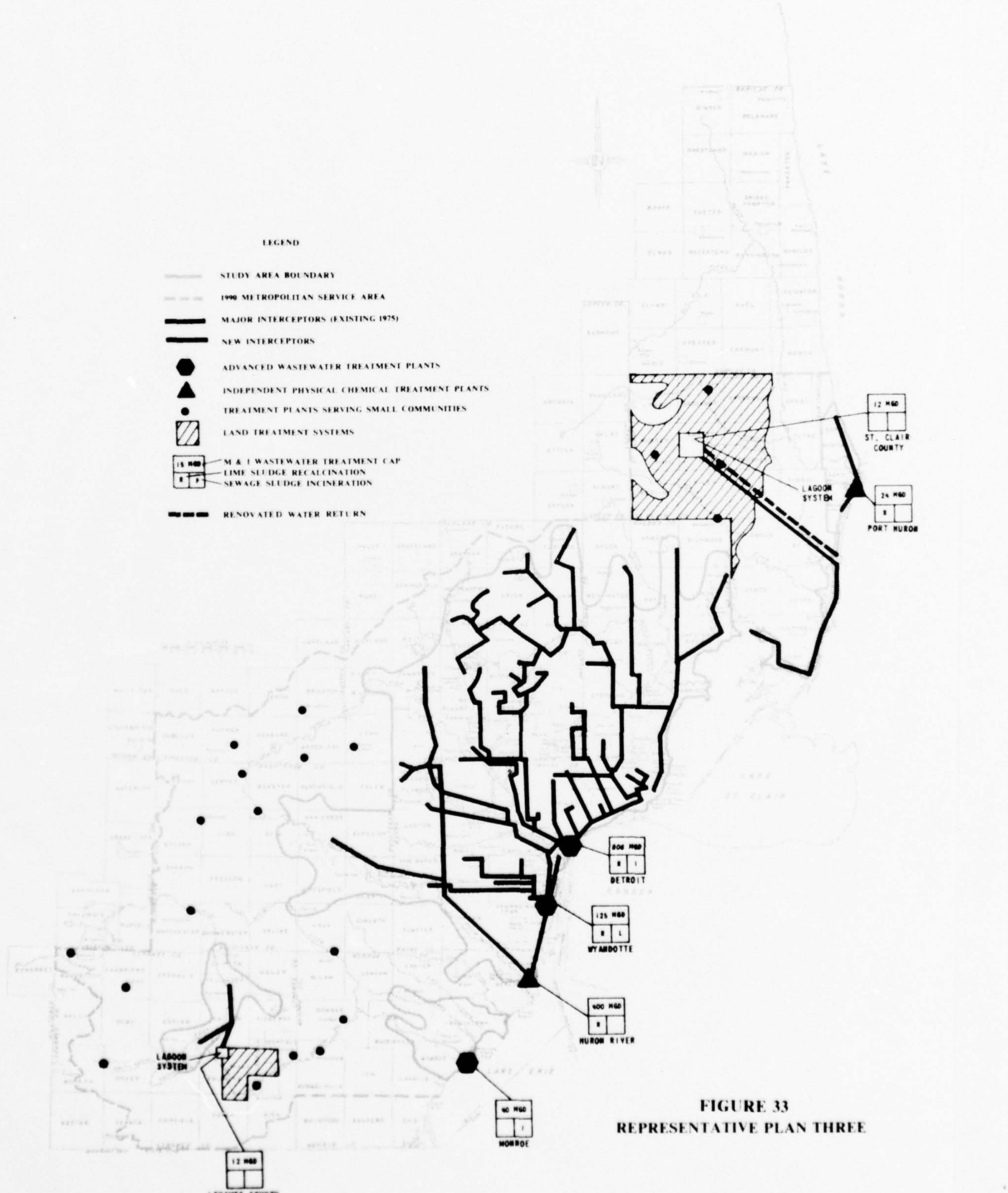

FIGURE 33
REPRESENTATIVE PLAN THREE

FIGURE 34

STORMWATER CONTROL SYSTEM FOR REPRESENTATIVE PLAN THREE

TABLE 21

REPRESENTATIVE PLAN THREE

	Facility Capacity (MGD) and Type Mun-Ind	Storm	Sludge Disposal Method*	Land Required (Acres)	Capital Cost $Million	Annual O&M Cost $Million	Total Annual Cost $Million
Wastewater Treatment Plants							
Port Huron	24 IPCT	-	REC,LF	--	10.9	1.5	2.2
Detroit	806 AWT	-	INC,REC,LF	320	385.3	42.6	66.2
Wyandotte	125 AWT	-	INC,REC,LF	100	68.1	8.2	12.4
Monroe	40 AWT	-	INC,LF	50	33.3	3.1	5.2
Huron River	400 IPCT	1000 IPCT	REC,LF	350	493.3	35.1	66.0
Macomb Co.	-	600 IPCT	REC,LF	160	181.5	8.3	19.2
Plymouth	-	225 IPCT	REC,LF	85	73.8	3.3	7.8
Ypsilanti	-	225 IPCT	REC,LF	85	73.8	3.3	7.8
Land Treatment Systems							
St. Clair Co Lagoons Sludge Disposal, Irrigation and Drainage	12 LAND	125 LAND	LA	2,576 (57,200)**	199.5	8.7	20.6
Lenawee Co. Lagoons, Sludge Disposal, Irrigation and Drainage	12 LAND	10.5 LAND	LA	815	62.3	2.3	6.0
Wastewater Interceptors and Transmission Lines				(15,320)**	336.7	2.5	23.0
Stormwater Collection, Storage and Transmission			LF	23,500	2,516.6	6.4	157.7
Landfill Sites							
St. Clair Co.				1,073	6.2	1.0	1.5
Lenawee Co.				2,338	11.3	1.9	2.7
SYSTEM TOTALS	1419	2185.5		31,452	4,497.6	128.3	398.3

*REC: Recalcination of lime sludge; LF: Landfill; INC: Incineration; LA: Land application

**Land required for irrigation to remain in private ownership.

Capital cost ammortization and total annual costs are based on 5.5% interest over 50 years

Chapter 8

DISCUSSION OF FINAL PLANS

Discussion of Impacts

In the preceding section, four plans were presented for consideration in the selection of a wastewater management plan for the Southeastern Michigan area. Impact identification tables were prepared for each of the four plans and can be found in the Evaluation Appendix. The tables identify impacts which would be realized if the plan were implemented. Many of the impacts, however, could only be identified as potential impacts that would require additional study if it became a significant factor in plan selection. The tables served only to identify impacts and did not attempt to relate the impacts to another plan.

To simplify the discussion of the impacts of the four final plans, only two of the impact tables will be used. The Interim Water Quality Plan Impact Identification Table, Table 22, is presented for use in the discussion of the Interim Water Quality Plan. Table 23 the Representative Plan One Impact Identification Table, will be used to discuss all three of the representative plans due to the similarity of the three plans.

Water Quality

Only the three representative plans would be capable of approaching the goal of "no discharge of pollutants" by 1985. The Interim Water Quality

TABLE 22

INTERIM WATER QUALITY PLAN IMPACT IDENTIFICATION TABLE

	THE IMMEDIATE VICINITY OF A WASTEWATER FACILITY	THE AREA IN SOUTHEASTERN MICHIGAN SERVED BY THE WASTEWATER SYSTEM	DIRECTLY AFFECTED AREAS OUTSIDE THE SERVICE AREA
I. WATER QUALITY			
A. SURFACE WATERS		Significant improvement could be expected in the water quality in the St. Clair, Clinton, Rouge, Huron, Detroit, Raisin and other inland rivers, however, lower water quality following storms would continue due to uncontrolled discharge of separate sewered urban storm runoff.	
		Peak storm flows would be equalized somewhat in the Rouge and Clinton Rivers due to the combined sewer overflow storage system.	
		Unless supplementary water supply was developed for the Ann Arbor-Ypsilanti area, abnormally low flows could occur in the lower Huron River.	
B. GROUND WATER	Ground water contamination could result from *poorly* managed disposal of stormwater solids and unincinerated sewage sludges.		
II. AQUATIC LIFE AND WATERFOWL		Habitats for intollerant game fish would be significantly improved in southeastern Michigan rivers and streams; however, artificial stocking would be required to maintain populations.	
III. PUBLIC HEALTH		Pathogen contamination from treatment plant effluents and combined sewer overflow would be reduced significantly; however, complete disinfection would not be achieved.	
		Infectious disease could be spread by waterfowl or other animals allowed access to surface stormwater storage lagoons.	
	A potential hazard would exist where large quantities of chlorine would be handled (On site chlorine production would significantly reduce the hazard).		
	Increased concentrations of pathogens could be expected in the air in the vicinity of activated sludge aeration basins.		
IV. ENERGY AND NATURAL RESOURCES A. AIR		Some gaseous (NO_x and SO_x) and particulate matter would be emmitted from sewage sludge incinerators.	
	A plume would be visible at incineration sites due to condensed water vapor.		
B. CHEMICALS		14,000 tons of chlorine (or raw materials, salt and electrical energy: 2600 kwhr/ton Cl_2) would be consumed annually.	
		Chemicals required for phosphorus removal would include lime, waste pickle liquor, iron salts, alum or other commercial chemicals. Quantities would be significant but have not been determined.	
C. ELECTRICAL POWER		132 megawatts of electrical power would be required to operate wastewater treatment plants. Additional electrical power would be required to operate the stormwater storage system.	
D. FUEL OIL OR NATURAL GAS		10 billion BTU of heat energy from fuel oil or natural gas would be required daily for sludge incineration.	

The comments in this table are intended to identify impacts only; each comment appears under the column identifying the area of greatest significance. The relative significance for other areas is identified by the screening indicated in the index to the right.

Equally Significant		Somewhat Significant	
Partially Significant		Insignificant	

THE REST OF THE STATE OF MICHIGAN	THE LAKE ERIE BASIN	THE NATION	CANADA - INTERNATIONAL
This plan would satisfy the water quality goals of the State of Michigan.		This plan would meet the interim (July 1983) water quality goals of P.L. 92-500 but if implemented would preclude achievement of the ultimate goals of the law by 1985.	This plan would meet the intent of the April [illegible] agreement with Canada on Great Lakes water quality.
	Employment of this degree of wastewater treatment throughout the Lake Erie basin would probably not be effective in achieving nutrient concentrations which would reduce algae problems in the lake.		
	Although lake water quality would be improved through implementation of this plan, the effects would not be obvious to the observer.		
	Any improvement in water quality in Lake Erie would not have an effect on fisheries in the lake unless proper management was practiced in the commercial fishing industry.		
	Improved wastewater management would be beneficial to waterfowl since habitats would be improved and concentrations of toxic substances and oils would be reduced.		

TABLE 22

INTERIM WATER QUALITY PLAN
IMPACT IDENTIFICATION TABLE
(CONTINUED)

	THE IMMEDIATE VICINITY OF A WASTEWATER FACILITY	THE AREA IN SOUTHEASTERN MICHIGAN SERVED BY THE WASTEWATER SYSTEM	DIRECTLY AFFECTED AREAS OUTSIDE THE SERVICE AREA
V. EMPLOYMENT		Labor demands for construction would cover a period of 10-12 years. Depending upon the design of the stormwater storage system, labor demands could exceed local supply.	
		Unemployment in the construction trades would be expected to drop with the advent of construction and increase upon completion of the project.	
		Operating manpower requirements for the wastewater plants would be 1500. Additional manpower would be required to staff the stormwater storage system.	
VI. LAND AND WATER USE CHANGES	Land use would have to be changed for the plant at the Huron River, for plant expansion at Wyandotte and Detroit, and for construction of the stormwater storage system.		
		The areas surrounding new treatment and storage facilities have a potential use by local units of government as open space and recreational areas.	
		Improved water quality in Lake St. Clair and inland rivers would allow increased development of water based recreation.	
VII. LAND VALUES	Some loss of property value may be experienced in the vicinity of wastewater management facilities due to the stigma associated with such facilities.		
		Land values along southeastern Michigan shorelines should increase due to improved water quality over the area and peak flow reduction in the Rouge and Clinton Rivers.	
VIII. AREA ECONOMY AND INSTITUTIONS		The history of growing intergovernmental cooperation in southeastern Michigan lays the basis for a regional approach to wastewater management.	
		781 acres of land for wastewater treatment plants and additional land for stormwater storage facilities would be removed from the tax base of local and county governments.	
		The regional economy would be stimulated temporarily due to demands for construction materials and increased construction payrolls.	
		There would be an area-wide decrease in disposable income of each family due to increased sewer charges to offset costs shown in X. below.	
		Implementation of the plan would be contrary to the goals of some communities, particularly Ann Arbor, which desire to maintain autonomy.	
		The creation of an unpolluted water supply would not have a significant effect on existing enterprizes, nor is it apt to attract new types of economic activity.	
IX. SOCIO-ECONOMICS	Owners of economic establishments and residents of lands required for construction of wastewater facilities would have to be relocated.		
	Residents of lands near proposed facilities would have their normal lifestyle disrupted and commercial enterprizes near-by would be affected while construction operations where underway.		
		The system would help satisfy a regional need for expanded water based recreation by providing more waters suitable for total body contact recreation.	
X. SYSTEM COSTS			
A. CAPITAL COSTS		$ 547,000,000	
B. AMORTIZED CAPITAL COST (Average annual)		32,000,000	
C. OPERATION AND MAINTENANCE (Average annual)		24,000,000	
D. TOTAL AVERAGE ANNUAL COST		56,000,000	

THE REST OF THE STATE OF MICHIGAN	THE LAKE ERIE BASIN	THE NATION	CANADA - INTERNATIONAL
	Improved water quality in Lake Erie through basin wide wastewater management could offer improved potential for development of water based recreation.		
		$ 1,643,000,000 97,000,000 97,000,000	

TABLE 23

REPRESENTATIVE PLAN ONE
IMPACT IDENTIFICATION PLAN

	THE IMMEDIATE VICINITY OF A WASTEWATER FACILITY	THE AREA IN SOUTHEASTERN MICHIGAN SERVED BY THE WASTEWATER SYSTEM	DIRECTLY AFFECTED AREAS OUTSIDE THE SERVICE AREA
I. WATER QUALITY			
A. SURFACE WATERS		Significant improvements could be expected in the water quality in the St. Clair, Clinton, Rouge, Huron, Detroit and Raisin Rivers due to elimination of urban stormwater and wastewater discharges.	
		Peak storm flows would be equalized in the Rouge, Huron and Clinton Rivers due to stormwater storage facilities.	
B. GROUND WATER	Ground water contamination could result from poorly managed sludge landfill areas (primarily nitrates and heavy metals).		
II. AQUATIC LIFE AND WATERFOWL		Habitats for intolerant game fish would be improved; however, artificial stocking would be required to maintain populations.	
III. PUBLIC HEALTH		Pathogen contamination from treatment plant effluents and uncontrolled discharge of urban storm runoff and combined sewer overflow would be virtually eliminated.	
		Infectious disease could be spread by waterfowl or other animals allowed access to stormwater storage lagoons.	
	A potential hazard would exist where large quantities of chlorine would be handled (On site chlorine production would significantly reduce the hazards).		
	Increased concentrations of pathogens could be expected in the air in the vicinity of treatment plant aeration basins.		
IV. ENERGY AND NATURAL RESOURCES A. AIR		Some gaseous (NO_x and SO_x) and particulate matter would be emitted from incineration, lime sludge recalcination and carbon regeneration facilities at treatment plant sites.	
	A plume would be visible at incineration and lime sludge recalcination sites due to condensed water vapor.		
B. CHEMICALS		155,400 tons of chlorine (or raw materials, salt and electrical energy: 2600 kwhr/ton Cl_2) would be consumed annually.	
		570,000 tons of lime (or raw materials, limestone rock and heat energy: 4.25-8.25 million BTU/ton lime) would be consumed annually.	
		51,000 tons of methanol (brewery waste could be substituted) would be consumed annually.	
C. ELECTRICAL POWER		The average electrical power demand of 265 megawatts is within the planned capabilities of Detroit Edison.	

The comments in this table are intended to identify impacts only; each comment appears under the column identifying the area of greatest significance. The relative significance for other areas is identified by the screening indicated in the index to the right.

Equally Significant	Somewhat Significant
Partially Significant	Insignificant

THE REST OF THE STATE OF MICHIGAN	THE LAKE ERIE BASIN	THE NATION	CANADA - INTERNATIONAL
This plan would result in water of higher quality than presently required by the State of Michigan.		This plan meets the intent and time phased goals of Public Law 92-500.	This plan would comply with the April 1972 agreement with Canada on Great Lakes water quality.
	There is little potential for significant improvement in the western half of Lake Erie with respect to algal blooms and oxygen depletion.		
	If similar wastewater management projects were carried out in the remainder of the Lake Erie basin, ecological recovery may be possible in the eastern half of the lake.		
	Although the habitat for intollerant fishes would be improved in Lake Erie, improvement of fisheries will depend on management practices in the commercial fishing industry.		
	Waterfowl populations may improve due to improved habitats and food supplies.		

TABLE 23

REPRESENTATIVE PLAN ONE
IMPACT IDENTIFICATION TABLE
(CONTINUED)

	THE IMMEDIATE VICINITY OF A WASTEWATER FACILITY	THE AREA IN SOUTHEASTERN MICHIGAN SERVED BY THE WASTEWATER SYSTEM	DIRECTLY AFFECTED AREAS OUTSIDE THE SERVICE AREA
C. ELECTRICAL POWER *(Continued)*		The additional 1850 *megawatts required for peak* stormwater pumping would be met by stand-by generators which could also serve as emergency back-up to the regional power grid.	
D. FUEL OIL OR NATURAL GAS		33 billion BTU of heat energy from fuel oil or natural gas would be required daily.	
V. EMPLOYMENT		Labor demands for construction would cover a period of 10-12 years. The demands for that period would exceed the local supply thus requiring labor from outside the region.	
		Unemployment in the construction trades would be expected to drop with the advent of construction and increase upon completion of the project.	
		The total operating manpower required would be 3249. Special training programs would be necessary to meet demands for technicians and specialty labor categories.	
VI. LAND AND WATER USE CHANGES	Essentially all of the proposed facilities would somewhat alter existing and proposed land use.		
		Buffer areas specified for most wastewater facilities have potential use by local units of government for *open space or recreational areas.*	
		Implementation of this plan would necessitate development of a supplementary water source for the Ann Arbor-Ypsilanti area to avoid abnormally low flows in the Huron River.	
	A potential would exist for developing local industrial water supplies utilizing renovated wastewater particularly in the vicinity of facilities near Adrian, Ypsilanti, Plymouth and the Huron River. Industrial expansion could thus be encouraged in areas previously not industrially oriented.		
VII. LAND VALUES		Land values along southeastern Michigan shorelines should increase due to improved water quality over the area and peak flow reduction in the Rouge and Clinton Rivers.	
	Some loss of property value may be experienced in the vicinity of wastewater management facilities due to the stigma associated with such facilities.		
VIII. AREA ECONOMY AND INSTITUTIONS		The history of growing intergovernmental cooperation in southeastern Michigan lays the basis for a regional approach to wastewater management.	
		Implementation and operation of this alternative would require one or several management organizations having a number of comprehensive *management capabilities (i.e. planning, financing,* construction, operation, maintenance and administrative capabilities).	
		Implementation of this plan would be contrary to the goals of some communities, particularly Ann Arbor, Pontiac and Warren, which desire to maintain autonomy.	
		28,200 acres of land would be removed from the tax base of local and county governments.	
		All existing treatment facilities in the service area with the exception of Detroit, Wyandotte, Port Huron and Monroe would be phased out by 1985.	
		The regional economy would be stimulated temporarily due to demands for construction materials and increased construction payrolls.	

THE REST OF THE STATE OF MICHIGAN	THE LAKE ERIE BASIN	THE NATION	CANADA – INTERNATIONAL

TABLE 23

REPRESENTATIVE PLAN ONE
IMPACT IDENTIFICATION TABLE
(CONTINUED)

	THE IMMEDIATE VICINITY OF A WASTEWATER FACILITY	THE AREA IN SOUTHEASTERN MICHIGAN SERVED BY THE WASTEWATER SYSTEM	DIRECTLY AFFECTED AREAS OUTSIDE THE SERVICE AREA
VIII. AREA ECONOMY AND INSTITUTIONS (Continued)		Gross income in the area would increase due to increased wastewater system payrolls; however, there be an area-wide decrease in disposable income of each family due to increased sewer charges to offset costs shown under X. below.	
		The creation of an unpolluted water supply would not have a significant effect on existing economic enterprizes, nor is it apt to attract new types of economic activity.	
IX. SOCIO-ECONOMICS	Owners of economic establishments and residents of lands required for construction of wastewater facilities would have to be relocated.		
	Residents of lands near proposed facilities would have their normal lifestyle disrupted and commercial enterprizes near-by would be affected while construction operations were underway.		
		The system would help satisfy a regional need for expanded water based recreation by providing more waters suitable for total body contact recreation.	
X. SYSTEM COSTS			
A. CAPITAL COSTS		$ 1,046,000,000	
B. AMORTIZED CAPITAL COST (Average annual)		62,000,000	
C. OPERATION AND MAINTENANCE (Average annual)		123,000,000	
D. TOTAL AVERAGE ANNUAL COST		185,500,000	

THE REST OF THE STATE OF MICHIGAN	THE LAKE ERIE BASIN	THE NATION	CANADA - INTERNATIONAL
		$ 3,137,000,000 185,000,000 185,000,000	

Plan could possibly achieve the 1983 objectives. The water quality objective of the State of Michigan and the objectives outlined in the April, 1972 agreement between the United States and Canada on Great Lakes water quality could be met by each of the four plans.

Implementation of any one of the four plans would result in significant improvements in the water quality of the inland rivers. The centralization of treatment facilities along the St. Clair and Detroit Rivers and Lake Erie would reduce the number of inland wastewater and combined sewer overflow discharges. Inland river water quality is expected to be higher for the Representative Plans than for the Interim Plan since urban storm runoff from separately sewered areas is addressed in the former. Each of the Representative Plans results in essentially the same improvements to inland river water quality.

A primary conclusion drawn from baseline studies conducted by the Institute of Water Research at Michigan State University was that ". . . even 100% elimination of municipal and industrial wastes from Southeastern Michigan, coupled with clean-up of Michigan's tributary streams, would not be adequate in significantly improving conditions in Lake Erie . . . for any major improvements of water quality to be realized in Lake Erie it is essential to reduce inputs from all watersheds bordering the Lake, not just Michigan's." The conclusions drawn were based on suggestions that "the single most outstanding treatment need for Lake Erie after disease threats are eradicated" was phosphorus removal. Assessment of abilities of the plans to improve water quality in Lake Erie were based on an assumption that similar plans would be implemented throughout the western basin and that proper land management and wastewater treatment would be employed to reduce phosphorus in tributary streams throughout the western basin.

Although the Interim Plan may have some effect on improving water quality in the Lake, algae related problems would not be affected and

improvement to the Lake may not be obvious. If any of the three Representative Plans were implemented, algae related problems in the eastern half of the Lake should be reduced. Improvement of the western half of the Lake would only be realized over a period of many years if at all.

The use of irrigation for treatment of wastewater as in Representative Plans Two and Three could result in increased ground water levels and an increase in stream flow in the vicinity of irrigation areas. Ground water contamination from irrigation areas should not be a problem. Ground water contaimination would be possible in the vicinity of areas used for disposal of stormwater sludges and incinerator ash from any one of the plans, from treatment and storage lagoons, and from land application of sludge associated with land irrigation treatment in Representative Plans Two and Three.

Aquatic Life and Waterfowl

The effect that any of the alternative plans would have on aquatic life habitats can be directly related to the degree of improvement in water quality. A primary problem to aquatic life in Lake Erie and inland streams is the maintenance of sufficient oxygen levels. Low oxygen levels result from both the oxygen demanding substances in waste discharges and from excessive plant growth resulting from an abundance of nutrients (phosphorus and nitrogen) in wastewater. In the alternatives, stream quality and thus aquatic habitats would be improved by increased levels of wastewater collection and treatment and by diversion of treated discharges to points further downstream. Storm runoff has been a serious problem in southeastern Michigan rivers and in the bays near the river mouths.

Many factors have led to the great change in fish populations in Lake Erie and inland streams; moreover, elimination of all urban waste discharges would not be sufficient for the system to recover to its previous

condition. Artificial stocking will continue to be necessary to maintain game fish populations. The evaluators concluded that "Changes in the fish population are probably much more dependent now on the management of fisheries in Lake Erie than on some reversal of eutrophication."

Improved water quality and aquatic life habitats would also have positive effects on waterfowl. Although the marsh lands bordering Lake Erie, Lower Detroit River, and Lake St. Clair have been reduced to a fraction of their former size and habitat deterioration from various forms of pollution has occurred, significant numbers of waterfowl still use the area. Improved wastewater management programs would be beneficial to waterfowl by controlling toxic substances such as oils, heavy metals, and biocides that may cause direct mortality, and by maintaining the plant and animal communities that serve as food.

Public Health

Restrictions placed on recreational use of Southeastern Michigan surface waters are primarily caused by contamination by pathogens (bacteria and virus) from partially treated wastewater discharges and combined storm and sanitary sewer overflows. Since all four plans place emphasis on eliminating sources of pathogen contamination, implementation of any of the plans would result in increased potential for recreational development of Southeastern Michigan surface waters. Conditions would be somewhat better if one of the three representative plans were implemented since disinfection measures would be much more efficient and more stormwater treatment would be employed.

There have been many potential public health hazards identified with treatment plant operations, wastewater lagoon treatment and land irrigation treatment. Some of those potential hazards include pathogen contamination of air in the vicinity of treatment plant aeration basins or

aerated lagoons, chlorine handling hazards, incineration of by-products, or disease transmission by waterfowl and wild game. Further study would be required into both engineering methods to avoid the problems and to determine the severity of the problems. The basic opinion of the evaluators, however, was that, until substantial data is available on land irrigation, wastewater treatment in plants would be the preferred method of treatment; thus, human consumption of crops grown on irrigated lands, as suggested in Representative Plan 3, should be discouraged. This would indicate that, with present knowledge, Representative Plan One would be preferred followed by Two and Three.

Energy and Natural Resources

All of the plans would employ incineration and related combustion techniques extensively. Designs call for use of advanced methods to insure complete combustion of exhaust gases and removal of essentially all particulate matter. Unless new techniques are developed, there are no practical means to remove oxides of nitrogen and sulfur from exhaust gases. At this point in time it would be difficult to assess the effect of the emissions on the atmosphere in Southeastern Michigan. The total quantity of combustion gas would be greatest for Representative Plan One, only slightly less for Representative Plans Two and Three, and much less for the Interim Water Quality Plan.

There is little difference in demands placed on energy (electrical and fuel), chemicals, or the atmosphere by the Representative Plans. The Interim Plan can be expected to have roughly half the demands for chemicals and energy estimated for the Representative Plans. The primary concern should be focused on energy requirements since the major resource consumed in manufacturing both lime and chlorine would be energy. Table 24 lists the electrical and fuel energy requirements, chemical requirements, and equivalent energy requirements identified for each plan.

TABLE 24

ENERGY AND CHEMICAL REQUIREMENTS

	Peak Electrical Power (Megawatts)	Average Electrical Power (Megawatts)	Fuel Oil or Natural Gas (10^9 BTU/Day)	Lime (Tons/Day)	Chlorine (Tons/Day)	Equivalent Electrical Energy (Megawatts)
Interim Water Quality Plan	NA	132	10	NA	38	136
Representative Plan One	2164	265	33	1550	426	315
Representative Plan Two	2205	290	33	1490	411	339
Representative Plan Three	2198	285	33	1490	411	334

Employment

Each of the plans could be implemented within the time frame dictated by the law, if an intensive program of construction was undertaken. This would result in excessive demands both for direct construction labor and labor which would be required for equipment fabrication and related fields. A question has been raised as to whether an area-wide demand for labor, materials and equipment could be met. Construction labor demands would be about equal for the Representative Plans and somewhat less for the Interim Plan.

Operating labor demands would not be excessive for any of the plans. Since operations at the plants are becoming more complex, the skill level of the wastewater treatment plant operators would have to be higher than in the past. The requirements could be met by instituting training programs far enough in advance of the need. The operating labor requirements for each plan are listed below:

Interim Water Quality Plan	1500 men
Representative Plan One	3249 men
Representative Plan Two	3197 men
Representative Plan Three	3163 men

Land and Water Use Changes

Of the four plans, the Interim Plan would cause the least change in existing and proposed land use. The primary changes would be due to location of stormwater storage facilities and location of the new Huron River treatment plant. The three Representative Plans share many common facilities and would for the most part have similar impacts on land use. The primary impacts would be a result of location of stormwater storage

facilities throughout the service area. Expansion of existing wastewater treatment plants in Detroit and Wyandotte would require displacement of land now in high density residential use.

The Representative Plans differ in the methods of handling wastewater in St. Clair and Lenawee Counties. In Plan One, 80 acres would be required in East China and 20 acres would be required in the Adrian area for wastewater-stormwater treatment plants. In Plans Two and Three there would be no plants in the East China or Adrian areas; however, agricultural land in both St. Clair and Lenawee Counties would be affected. For both plans 4,120 and 590 acres, respectively, would be required for treatment and storage lagoons in St. Clair and Lenawee Counties. That would probably displace land in agricultural use. An additional 1,059 and 450 acres respectively of agricultural land would be devoted to sludge disposal and forage crop production. In Plan Two 18,600 acres in St. Clair County and 3,900 acres in Lenawee County would be used for irrigation of wastewater. Although the land would be maintained in agricultural use, crops would be restricted to forage type and control of the land would rest with the managing agency. In Plan Three 53,600 acres in St. Clair County and 16,550 acres in Lenawee County would be irrigated; however, crop types would not be restricted and control would rest with the individual farmer.

Each of the plans offers opportunities for expanded recreation and open space development in the vicinity of new wastewater facilities. Improved water quality would also contribute to development of recreation. The degree of development of opportunities would have to be the choice of the implementing agency or the local governmental unit.

Opportunities for developing water reuse have been discussed in Chapter 3 of the Summary Report. The greatest opportunities would be presented in the Representative Plans, primarily in those plans which utilize irrigation.

Land Values

Changes in land values, as a result of plan implementation, would be due to improved water quality or proximity of wastewater facilities. Land values could be expected to increase along shorelines and in the vicinity of developed recreational areas. Some decrease in values could be expected due to odor problems or the general stigma associated with wastewater. No general comparison between plans would be feasible since these effects would be local in nature.

Area Economy and Institutions

A sound basis exists for regional wastewater management in Southeastern Michigan. The most severe problem to be encountered in implementing one of the plans would be the acquisition of land required for stormwater storage and wastewater treatment facilities. Resistance from communities forced to abandon existing treatment plants would also pose problems.

Another problem for local governmental units would be the loss of land from tax rolls. This could be a significant factor in selection of a method of treatment in St. Clair County since Plan One would require 80 acres, Plan Two 23,800 acres and Plan Three 5,200 acres.

The construction program associated with implementation of one of the plans would have a significant effect on the local economy through increased payrolls, increased demand for construction materials and machinery, and secondary economic effects. Costs to individual families for wastewater treatment would increase since the local share of the construction cost and operation and maintenance costs would be paid through user charges. Impacts would be greater for the Representative Plans than for the Interim Plan.

With the exception of the reuse potentials discussed in Chapter 3 of the Summary Report, there should be no direct effect of expanded wastewater treatment on existing economic enterprises.

Socio-Economics

Implementation of any plan of this magnitude would require displacement of individuals who occupy the affected land. Depending upon the individuals and how the displacement is handled, the overall impact could be positive or negative. No precise data was developed giving the number of families affected by each proposed facility so there are no numerical comparisons of the effects of implementing each alternative. Some degree of comparison can be made based on the amount of land required for each plan.

A positive social effect would result from expansion of open space and recreational development. The degree of development, as previously pointed out, would depend on local units of government.

System Costs

The costs estimated for the four final plans are presented in Table 25. The capital costs and operation and maintenance costs are based on cost indices for Detroit, January 1972. All annual costs are computed for a project life of 50 years and an annual interest rate of 5-1/2%.

It is obvious that there is a distinct cost difference between the Interim Plan and the three Representative Plans; however, there is no significant difference in total cost between the Representative Plans. When comparing the Representative Plans on a cost basis, the cost differential becomes more obvious when examined only for the service areas in St. Clair County and Lenawee County.

TABLE 25

COST COMPARISON OF REPRESENTATIVE PLANS

	Construction Cost $Million	Annual O&M Cost $Million	*Annual Cost to Southeastern Michigan $Million	Total Annual Cost $Million
Interim Water Quality Plan	2,190	23.5	56.0	153.0
Representative Plan One	4,184	123.5	185.5	370.6
Representative Plan Two	4,257	124.2	187.1	375.6
Representative Plan Three	4,498	132.7	199.1	398.3

*Based on 25% local financing of initial capital cost and total local funding of operation and maintenance costs.

Institutional Management Schemes

As was stated in Chapter 5, the purpose of an investigation of institutional management schemes is to analyze the capabilities of existing and proposed wastewater management organizations relative to selected technical wastewater management systems. A number of institutional management schemes, each possessing sufficient authority to plan, construct, operate and maintain the systems developed during the study, have been proposed for the Southeastern Michigan area. These institutions can be classified in six categories which cover management on various levels of political interaction. These six classifications involve wastewater management by:

- State Agency or Utility
- Regional Agency
- County Agency
- Municipal or Local Agency
- Water and Sewage Authority
- Management thru Intergovernmental service agreements (referred to as intercounty agreements)

1. STATE AGENCY OR UTILITY - This type of institutional mechanism involves an executive or departmental agency to the State actually undertaking the direct performance of an urban function. In practice, aspects of functions may be transferred to a State agency rather than the total function. For example, if a State agency provides water for a metropolitan region, it (the State agency) is usually responsible for the actual source of the water supply plus the major trunk lines to convey the water from the source throughout the metropolitan region. Local distribution systems are, however, often left to the localities themselves.

2. REGIONAL AGENCY - The multiple purpose District/Authority represents an independent unit of government established through State law to perform a number of services in all or most portions of a metropolitan area. The multiple purpose District/Authority may be established initially with only 1 or 2 actual functions; however, the enabling legislation vests in the area affected the capability for the District/Authority to take on additional functions as the need arises.

3. COUNTY AGENCY - Under this type of an arrangement, the county government increases its provision of services which are normally of a municipal nature to include the entire county. This action requires the transfer of functions from municipalities and any special districts together with the gradual expansion of activities in unincorporated urban areas. It may be necessary for the State to grant a number of functional powers to counties in metropolitan areas. Act 342, Public Acts of 1939 allows a county to provide wastewater management services within its boundary as well as in consenting neighboring governmental units. (Unless otherwise identified, Public Acts refer to current wastewater management legislation in the State of Michigan).

Certain legislative acts stipulate that the county agency is capable of providing services within a boundary specifically limited to a local area. Act 40, Public Acts of 1956, Chapter 20, stipulates that a designated "agency" in this case a drain commission, may provide for collection and transmission of wastewater within a county. Act 185, Public Acts of 1957, established a Department of Public Works to provide for WWM services within a county.

4. MUNICIPAL OR LOCAL AUTHORITY - The limited purpose metropolitan special district or authority is an independent unit of government organized to perform one or more urban functions throughout all or a part of a metropolitan area. In most cases, the activity is service as opposed to regulatory, for example water supply or sewage disposal. The financing of such an independent unit of government is primarily through service changes, sales, rents, tolls. Revenue bonds constitute the primary source of capital funds for project construction.

5. WATER AND SEWAGE AUTHORITY - Act 233, Public Acts of 1955 allows for the establishment, by consenting governmental units, of an authority to provide both wastewater and water supply services. The authority can finance facility construction by the provision of contract bonding and, in this aspect, the provisions are similar to those mentioned in Act 342, Public Acts of 1939. Full faith and credit for these bonds is established by the financial stability of the contracting governmental units.

6. MANAGEMENT THRU INTERGOVERNMENTAL SERVICE AGREEMENTS - Under such a device, one unit of government conducts an activity jointly or cooperatively with one or more other units of governments. Typically, contracts may be drawn up whereby one public corporation or unit of government agrees to provide specified services to other units of government according to terms specified in the contracts; therefore, the extraterritorial power represents the exercise of authority by one unit of government beyond its traditional political boundary. For example, the Detroit Metropolitan Water Department and the Wayne County Road Commission provide sewage service to communities under Intergovernmental Service Agreements.

The examination of these six institutional management schemes took place in two evaluations. The first was to determine the potential of five existing representative wastewater institutions created by current legislation, to implement proposed regional wastewater management plans. The second evaluation examined a range of institutional management schemes which involved the combination of existing and proposed management systems.

In the initial evaluation the following existing institutions would be most capable of managing the proposed alternatives:

1) The Michigan Water Resources Commission (WRC) Department of Natural Resources (DNR) was selected for examination as a State agency

because of its numerous wastewater management responsibilities. In 1972, the WRC undertook the drainage responsibilities of the Department of Agriculture and the wastewater engineering responsibilities of the Engineering Division, Department of Public Health.

2) For a representative regional wastewater management institution the Detroit Metropolitan Water Department (DMWD) was selected. The DMWD provides wastewater treatment for 79 communities, and supplies water for 92 communities. Its legislation allows it to provide service by contracts, akin to the nomenclature "management thru intergovernmental service agreements".

3) Act 185, Public Acts of 1957, is the legislation establishing a county department of public works, while Act 40, Public Acts of 1956 establishes a county drain commission. An evaluation of the utilization of wastewater management legislation in the Southeastern Michigan Wastewater Management Study Area depicts that these two acts are most frequently employed to undertake comprehensive wastewater management responsibilities.[1] Thus, these two acts were examined.

4) Legislation which allows a governmental agency to provide comprehensive wastewater management in the State of Michigan on a county basis, in addition to expanding its boundaries, is Act 342, Public Acts of 1939 - The County Public Improvement Act. An example of an agency using this legislation for wastewater responsibilities is the Wayne County Road Commission.

These then were the categories of institutions which were selected as being representative wastewater management institutions for the Study Area for the initial evaluation.

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[1] Page 114, Table 12, Management On A Local Jurisditional Level, Institutional Arrangements Appendix.

An assessment was undertaken to determine the ability of these institutions, utilizing current legislation, to provide the comprehensive wastewater management responsibilities inherent in the seven selected alternatives.

The following is a synopsis of the preceding initial evaluation denoting the ability of representative institutions to implement the Corps alternatives.

1. State Institutions (Water Resources Commission - WRC) - The State (WRC) cannot presently implement any of the alternatives without major institutional additions.

2. Regional Institutions (Detroit Metropolitan Water Department - DMWD) - Except where the Detroit-Jefferson Avenue Plant is phased out, resulting in financial loss considerations, DMWD in its present form could implement the alternatives with little difficulty.

3. Local Institutions (Act 342, Public Acts of 1939) - Except where the Wyandotte Plant is phased out, (Combination 1) resulting in financial loss considerations, Act 342, Public Acts of 1939, affords the designated management agency the ability to implement any of the alternatives.

4. Local Institutions (Act 185, Public Acts of 1957 and Act 40, Public Acts of 1956) - Act 185, Public Acts of 1957, and 40, Public Acts of 1956, may be utilized to implement any alternative with certain limitations; due mainly to jurisdictional limitations and the extent of wastewater management authority.

A subsequent analysis of potential management institutions was undertaken to assess the feasibility of a number of potential organizations to implement the technical wastewater management alternatives.

A summary of the findings depicts the following:

- The alternative utilizing only the land irrigation treatment concept is best implemented by a State Utility, a Regional Government, or a Wastewater Authority;

- Implementation of a total Independent-Physical Chemical alternative, designating the total utilization of physical-chemical plants for treating municipal and industrial wastewater, in addition to combined sewer overflows and storm runoff could be accomplished by a State Utility, a Regional Government, a Water and Sewage Authority, and a County Government;

- Five feasible management institutions could implement an Advanced Wastewater Treatment, alternative. These are a State Utility, a Regional Government, a Water and Sewage Authority, a County Government, and management through Intergovernmental Service Agreements.

The two evaluations were analyzed in light of the final 3 representative wastewater management plans. The analysis and examination of these representative institutional classifications, with respect to the revised selected plans (and the potentially related degrees of political interaction, extension of political boundaries, etc.) has shown that Representative Plans One, Two, and Three may be effectively undertaken by the following management schemes in the order of least implementable difficulty to major institutional problems:[1]

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[1] Refer to pages 157, 158 of the Institutional Arrangements Appendix for further discussion.

1. **Regional Agency**
2. **Water and Sewage Authority**
3. **Intercounty Agreements**
4. **State Agency**
5. **County Agency**
6. **Local or Municipal Agency**

Bonded Indebtedness and Community Reimbursement

The phasing out of certain existing wastewater treatment plants would occur in any of the four plans presented as final alternatives for choice. As the regional facility becomes available, there would be no need for these plants. Two financial considerations are inherent in the phasing out of any public facility; they are: outstanding bonded indebtedness, and community reimbursement.

Outstanding Bonded Indebtedness

In the southeastern Michigan area, as in most metropolitan regions, the management of wastewater treatment facilities is a revenue producing operation. The operating agency may, in addition to other revenues, rely on a municipal and industrial user rates and fees or the establishment of special assessment districts and charges. This revenue may then be used to supplement financing of plant operation and maintenance, partially finance new construction, and repay outstanding bonded indebtedness.

The Municipal Finance Commission is a State of Michigan agency directed to preview and sanction all utility bond sales and maintain records of the resulting bonded indebtedness.

The following bonded indebtedness examples are drawn from their records.

The City of Adrian is currently serviced by a wastewater treatment plant which discharges to the Raisin River. This treatment plant is scheduled to be phased out in each of the wastewater management alternatives

considered in this study. The treatment plant would be replaced by either a regional independent physical-chemical treatment plant (Representative Plan One) or a regional land irrigation treatment system (Representative Plans Two and Three).

Adrian has two outstanding bonds relating to the operation of its treatment plant. A bond issued in 1950 has an indebtedness of $269,000; while, a bond sold in 1953 has an indebtedness of $2,000. Both bonds are general obligation in nature, and the indebtedness figure is as of 30 June 1973

Through its authorized agency, the City of Mt. Clemens issued a bond in 1949 for the construction of a treatment plant and sewers. The outstanding indebtedness figure also as of 30 June 1973, on this revenue bond is $369,000. The wastewater management plans considered in this study designate the phasing out of this plant, and the service area to be subsequently managed by a regional treatment plant at the present location of the Jefferson Avenue plant in Detroit.

Similar situations exist throughout the study area. The total bonded indebtedness for wastewater related facilities, including sewers and treatment plants, approaches $300 million. Of this amount it has been estimated that at least 40 percent can be directly attributed to treatment plants. This bonded indebtedness figure must be incorporated into the final system cost when new wastewater management alternatives are considered.

Community Reimbursement

The reimbursement of communities for treatment plants being phased out of existence is a sensitive matter. The amount of the reimbursement is difficult to determine depending on existing bonded indebtedness, current assessed value of the facilities, and other factors. One method of determining reimbursement is designated by existing State of Michigan wastewater management legislation.

Act 329, Public Acts of 1966 of the State of Michigan, stipulates that governmental units participating in regional wastewater management plans approved by the State of Michigan's Water Resources Commission

are eligible to receive a grant for 50 percent of the existing facilities being phased out and replaced by a regional facility.

The land value and any state or federal grant issued for the construction of the phased out facility is to be deducted from this eligible amount. This Act also stipulates that the grant shall be made only if the regional local agency has entered into an agreement for acquisition of the treatment facilities to be replaced, and applies the grant toward such acquisition.

It is possible that the amount of money a community would receive as reimbursement, under this Act, would not be sufficient to repay the outstanding bonded indebtedness on the phased out facility. Other methods of reimbursement may be desired to eliminate the loss of revenue by the local communities.

Phasing and Implementation

Although the Interim Water Quality Plan was designed to achieve the 1983 objectives and the Representative Plans were designed to approach the 1985 objectives of Public Law 92-500, each plan could be implemented so that interim objectives of the law could be met. However, it must be recognized that the implementation of the Interim Water Quality Plan would preclude the implementation of any of the Representative Plans by the specified date of 1985. If the Interim Plan was selected for implementation, any one of the Representative Plans could be achieved and many of the facilitites from the Interim Plan could be used but additional time (up to 15 years) would be required for implementation. It is most probable however that revisions would be made or a new plan would be designed if the Interim Plan was selected and a higher degree of treatment was to be met at a later date. Since planning is a continuous process, this is a logical assumption.

Construction sequencing will be an important factor in achieving the interim and final objectives on schedule. The phasing of construction and facility start-up will control the flow of money in the project. The structuring of the construction and start-up or phasing and implementation program for each alternative plan will facilitate the examination of comparative economic costs.

Priorities and Policies

Sequencing of construction and start-up is controlled by: interim water quality objectives, funding schedules and construction practicality. The following is a list of some of the more important priorities and policies:

a. Construction program to commence on 1 January 1975.

b. Construction of the Interim Plan to be complete by 1 July 1983 and Representative Plans by 1 January 1985.

c. 1977 and 1983 objectives of the law to be met.

d. Premature investment of capital to be avoided by construction sequencing.

e. Pilot plant study to be employed prior to final facility design.

f. Combined sewer service areas to be given priority in construction of the stormwater management system.

g. Stormwater storage facilities to have priority over stormwater treatment.

h. Soil erosion to be controlled in rural and outer suburban areas by use of good land management practices.

Procedure

The phasing of the various plans applies to only those new treatment systems or components that would be added to the base (1975) system. Construction costs include the capital investments needed to build facilities required to achieve the relevant water quality objectives within the legal schedule. As newly constructed facilities are placed in operation, their appropriate O and M and replacement costs commence. O and M costs for those components in place by 1975 are not included or considered prior to this date. When an existing component is incorporated into a proposed system and additional processes are added after 1975, to achieve the appropriate water quality objectives, the entire O and M costs (for both new and old processes) are included in the phasing costs.

Two constraints are imposed on the phasing and implementation programs in order to facilitate the comparison of impacts caused by

the alternatives. First, the construction schedule and the start-up schedule for a given system are identical for all alternatives and are specified by total construction capital expended versus time and by percentage of 1990 capacity placed in operation versus time, respectively. Second, the percentage of total construction capital expended versus time is held to a uniform rate. The above two constraints are compatible with logical implementation programs for each of the alternatives and provide, at the same time, for an effective and efficient comparison of impacts of the alternatives.

A third constraint, or freedom from constraint in this case, is that construction capital funds are available appropriate to the phasing selected.

The programs for the Representative Plans, Nos. one, two and three are in Tables 26 to 37 inclusive. In explanation of these tables:

Column 1 is the capital cost, that is the cost of constructing the separate members that are listed and comprise the regional system.

Column 2 is the required expenditure each year for ten years to build the entire system in the interval 1975 to 1985.

Column 3 shows the present worth of the sums required for the disbursements each year in Column 2; that is these amounts posted at the beginning of 1975 would generate at the specified percent the sums necessary for each 10 year of construction payment.

Column 4 gives the payments that must be made each year for 50 years to amortize the construction capital costs which in turn are paid from the sums generated by the present worth amounts shown in Column 2.

The totals for the separate members are shown at the bottom; the total expenditure over 50 years is also shown at the bottom of Column 4.

TABLE 26

REPRESENTATIVE PLAN ONE-CAPITAL COST, YEARLY EXPENDITURES, PRESENT WORTH AND AVERAGE ANNUAL COST IN $1,000,000

INTEREST RATE: 5%

COLUMN	1	2	3	4
System	Capital Cost	Yearly Expenditure 1975 to 1985	P.W. of Yearly Expenditures @ 5% - 1975-1985 Col. 2x7.722	Average Annual Cost 50 Yrs @ 5% Col. 3x0.054777
Wastewater Treatment Plants	1,389.08	138.91	1,072.66	58.75
Wastewater Interceptors and Transmission Lines	214.61	21.46	165.71	9.07
Stormwater Collection Storage and Transmission	2,561.60	256.16	1,978.06	108.35
Landfill Sites				
St. Clair County	6.47	0.647	4.99	0.27
Lenawee County	11.7	1.17	9.03	0.49
TOTALS	4183.46	418.34	3230.45	176.93
Total of 50 yr payments from 1975 to 2025				8,845.0

TABLE 27

REPRESENTATIVE PLAN TWO-CAPITAL COST, YEARLY EXPENDITURES, PRESENT WORTH AND AVERAGE ANNUAL COST IN $1,000,000

INTEREST RATE: 5%

COLUMN	1	2	3	4
System	Capital Cost	Yearly Expenditure 1975 to 1985	P.W. of Yearly Expenditures @ 5% - 1975-1985 Col. 2x7.722	Average Annual Cost 50 Yrs @ 5% Col. 3x0.054777
Wastewater Treatment Plants	1,320.05	132.005	1019.34	55.83
Land Treatment Systems				
St. Clair County	62.81	6.281	48.50	2.65
Lenawee County	24.52	2.452	18.93	1.03
Wastewater Interceptors and Transmission Lines	236.44	23.644	182.57	10.00
Stormwater Collection Storage and Transmission	2,561.60	256.16	1978.06	108.35
Landfill Sites				
St. Clair County	6.15	0.615	4.74	0.25
Lenawee County	11.28	1.128	8.71	0.47
TOTALS	4,222.8	422.285	3,260.85	178.58
Total of 50 yr payments from 1975 to 2025				8,929.0

TABLE 28

REPRESENTATIVE PLAN THREE-CAPITAL COST, YEARLY EXPENDITURES, PRESENT WORTH AND AVERAGE ANNUAL COST IN $1,000,000

INTEREST RATE: 5%

COLUMN	1	2	3	4
System	Capital Cost	Yearly Expenditure 1975 to 1985	P.W. of Yearly Expenditures @ 5% - 1975-1985 Col. 2x7.722	Average Annual Cost 50 Yrs @ 5% Col. 3x0.054777
Wastewater Treatment Plants	1,320.05	132.005	1,019.34	55.83
Land Treatment Systems				
St. Clair County	194.5	19.45	150.19	8.22
Lenawee County	63.6	6.36	49.11	2.69
Wastewater Interceptors and Transmission Lines	236.44	23.644	182.57	9.99
Stormwater Collection Storage and Transmission	2,561.60	256.16	1,978.06	108.35
Landfill Sites				
St. Clair County	6.15	0.615	4.74	0.25
Lenawee County	11.28	1.128	8.71	0.47
TOTALS	4,393.62	439.36	3,392.72	185.80
Total of 50 yr payments from 1975 to 2025				9,290.0

TABLE 29

REPRESENTATIVE PLAN ONE-CAPITAL COST, YEARLY EXPENDITURES, PRESENT WORTH AND AVERAGE ANNUAL COST IN $1,000,000

INTEREST RATE: 5-1/2%

COLUMN	1	2	3	4
System	Capital Cost	Yearly Expenditures 1975 to 1985	P.W. of Yearly Expenditures @ 5-1/2%-1975-1985 Col. 2x7.538	Average Annual Cost 50 Yrs @ 5-1/2% Col. 3x0.059061
Wastewater Treatment Plants	1,389.08	138.91	1,047.10	61.84
Wastewater Interceptors and Transmission Lines	214.61	21.46	161.77	9.55
Stormwater Collection Storage and Transmission	2,561.60	256.16	1,930.93	114.04
Landfill Sites				
St. Clair County	6.47	0.647	4.87	0.28
Lenawee County	11.7	1.17	8.81	0.52
TOTALS	4,183.46	418.34	3,153.48	186.23
Total of 50 yr payments from 1975 to 2025				9,311.50

TABLE 30

REPRESENTATIVE PLAN TWO-CAPITAL COST, YEARLY EXPENDITURES, PRESENT WORTH AND AVERAGE ANNUAL COST IN $1,000,000

INTEREST RATE: 5-1/2%

COLUMN	1	2	3	4
System	Capital Cost	Yearly Expenditure 1975 to 1985	P.W. of Yearly Expenditures @ 5-1/2%-1975-1985 Col. 2x7.538	Average Annual Cost 50 Yrs @ 5-1/2% Col. 3x0.059061
Wastewater Treatment Plants	1,320.05	132.005	995.05	58.769
Land Treatment Systems				
St. Clair County	62.81	6.281	47.35	2.796
Lenawee County	24.52	2.452	18.48	1.09
Wastewater Interceptors and Transmission Lines	236.44	23.644	178.23	10.526
Stormwater Collection Storage and Transmission	2,561.60	256.16	1930.93	114.04
Landfill Sites				
St. Clair County	6.15	0.615	4.64	0.274
Lenawee County	11.28	1.128	8.50	0.502
TOTALS	4,222.8	422.28	3,183.18	187.997
Total of 50 yr payments from 1975 to 2025				9,399.85

TABLE 31

REPRESENTATIVE PLAN THREE-CAPITAL COST, YEARLY EXPENDITURES, PRESENT WORTH AND AVERAGE ANNUAL COST IN $1,000,000

INTEREST RATE: 5-1/2%

COLUMN	1	2	3	4
System	Capital Cost	Yearly Expenditures 1975 to 1985	P.W. of Yearly Expenditures @ 5-1/2%-1975-1985 Col. 2x7.538	Average Annual Cost 50 Yrs @ 5-1/2% Col. 3x0.059061
Wastewater Treatment Plants	1,320.05	132.005	995.05	58.769
Land Treatment Systems				
St. Clair County	194.5	19.45	146.61	8.659
Lenawee County	63.6	6.36	47.94	2.831
Wastewater Interceptors and Transmission Lines	236.44	23.644	178.23	10.526
Stormwater Collection Storage and Transmission	2,561.60	256.16	1,930.93	114.04
Landfill Sites				
St. Clair County	6.15	0.615	4.64	0.274
Lenawee County	11.28	1.128	8.50	0.502
TOTALS	4,393.62	439.36	3311.9	195.601
Total of 50 yr payments from 1975 to 2025				9,780.05

TABLE 32

REPRESENTATIVE PLAN ONE-CAPITAL COST, YEARLY

EXPENDITURES, PRESENT WORTH AND AVERAGE

ANNUAL COST IN $1,000,000

INTEREST RATE: 7%

COLUMN	1	2	3	4
System	Capital Cost	Yearly Expenditure 1975 to 1985	P.W. of Yearly Expenditures @ 7% - 1975-1985 Col. 2x7.024	Average Annual Cost 50 Yrs @ 7% Col. 3x0.072460
Wastewater Treatment Plants	1,389.08	138.91	975.70	70.69
Wastewater Interceptors and Transmission Lines	214.61	21.46	150.73	10.92
Stormwater Collection Storage and Transmission	2,561.60	256.16	1,799.26	130.37
Landfill Sites				
St. Clair County	6.47	0.647	4.54	0.32
Lenawee County	11.7	1.17	8.21	0.59
TOTALS	4,183.46	418.34	2,938.44	212.89
Total of 50 yr payments from 1975 to 2025				10,644.5

TABLE 33

REPRESENTATIVE PLAN TWO-CAPITAL COST, YEARLY

EXPENDITURES, PRESENT WORTH AND AVERAGE

ANNUAL COST IN $1,000,000

INTEREST RATE: 7%

COLUMN	1	2	3	4
System	Capital Cost	Yearly Expenditure 1975 to 1985	P.W. of Yearly Expenditures @ 7% - 1975-1985 Col. 2x7.024	Average Annual Cost 50 Yrs @ 7% Col. 3x0.072460
Wastewater Treatment Plants	1,320.05	132.005	927.20	67.18
Land Treatment Systems				
St. Clair County	62.81	6.281	44.11	3.19
Lenawee County	24.52	2.452	17.22	1.24
Wastewater Interceptors and Transmission Lines	236.44	23.644	166.07	12.03
Stormwater Collection Storage and Transmission	2,561.60	256.16	1,799.26	130.37
Landfill Sites				
St. Clair County	6.15	0.615	4.31	0.31
Lenawee County	11.28	1.128	7.92	0.51
TOTALS	4,222.8	422.285	2966.09	214.89
Total of 50 yr. payments from 1975 to 2025				10,744.50

TABLE 34

REPRESENTATIVE PLAN THREE-CAPITAL COST, YEARLY

EXPENDITURES, PRESENT WORTH AND AVERAGE

ANNUAL COST IN $1,000,000

INTEREST RATE: 7%

COLUMN	1	2	3	4
System	Capital Cost	Yearly Expenditure 1975 to 1985	P.W. of Yearly Expenditures @ 7% - 1975-1985 Col. 2x7.024	Average Annual Cost 50 yrs @ 7% Col. 3x0.07246
Wastewater Treatment Plants	1,320.05	132.005	927.20	67.18
Land Treatment Systems				
St. Clair County	144.5	19.45	136.61	9.89
Lenawee County	63.6	6.36	44.67	3.23
Wastewater Interceptors and Transmission Lines	236.44	23.644	166.07	12.03
Stormwater Collection Storage and Transmission	2,561.60	256.16	1,799.26	130.37
Landfill Sites				
St. Clair County	6.15	0.615	4.31	0.31
Lenawee County	11.28	1.128	7.92	0.57
TOTALS	4,393.62	439.36	3,086.04	223.58
Total of 50 yr. payments - 1975 to 2025				11,179.0

TABLE 35

REPRESENTATIVE PLAN ONE - CAPITAL COST, YEARLY

EXPENDITURES, PRESENT WORTH AND AVERAGE

ANNUAL COST IN $1,000,000

INTEREST RATE : 10%

COLUMN	1	2	3	4
System	Capital Cost	Yearly Expenditure 1975 to 1985	P.W. of Yearly Expenditures @ 10% - 1975-1985 Col. 2x6.145	Average Annual Cost 50 Yrs 10% Col 3xx.100859
Wastewater Treatment Plants	1389.08	138.91	853.60	86.09
Wastewater Interceptors and Transmission Lines	214.61	21.46	131.87	13.30
Stormwater Collection Storage and Transmission	2,561.60	256.16	1,574.10	158.76
Landfill Sites				
St. Clair County	6.47	0.647	3.97	0.40
Lenawee County	11.7	1.17	7.18	0.72
TOTALS	4183.46	418.35	2570.72	259.27
Total of 50 yr payments - 1975 to 2025				12,963.50

TABLE 36

REPRESENTATIVE PLAN TWO CAPITAL COST, YEARLY

EXPENDITURES, PRESENT WORTH AND AVERAGE

ANNUAL COST IN $1,000,000

INTEREST RATE: 10%

COLUMN	1	2	3	4
System	Capital Cost	*Yearly* Expenditure 1975 to 1985	P.W. of Yearly *Expenditures @* 10% 1975-1985 Col. 2x6.145	*Average* Annual Cost 50 yrs @ 10% Col.3x0.100859
Wastewater Treatment Plants	1,320.05	132.005	811.17	81.81
Land Treatment Systems				
St. Clair County	62.81	6.281	38.59	3.89
Lenawee County	24.52	2.452	15.06	1.51
Wastewater Interceptors and Transmission Lines	236.44	23.644	145.29	14.65
Stromwater Collection Storage and Transmission	2,561.60	256.16	1,574.10	158.76
Landfill Sites				
St. Clair County	6.15	0.615	3.77	0.38
Lenawee County	11.28	1.128	6.93	0.69
TOTALS	4,222.8	422.285	2,594.91	261.69
Total of 50 yr payments - 1975 to 2025				13,084.5

TABLE 37

REPRESENTATIVE PLAN THREE CAPITAL COST, YEARLY

EXPENDITURES, PRESENT WORTH AND AVERAGE

ANNUAL COST IN $1,000,000

INTEREST RATE: 10%

COLUMN	1	2	3	4
System	Capital Cost	Yearly Expenditure 1975 to 1985	P.W. of Yearly Expenditures @ 10% - 1975-1985 Col. 2x6.145	Average Annual Cost 50 yrs @ 10% Col. 3x0.100859
Wastewater Treatment Plants	1,320.05	132.005	811.17	81.81
Land Treatment Systems				
St. Clair County	194.5	19.45	119.52	12.05
Lenawee County	63.6	6.36	39.08	3.94
Wastewater Interceptors and and Transmission Lines	236.44	23.644	145.29	14.65
Stormwater Collection Storage and Transmission	2,561.60	256.16	1,574.10	158.76
Landfill Sites				
St. Clair County	6.15	0.615	3.77	0.38
Lenawee County	11.28	1.128	6.93	0.69
TOTALS	4,393.62	439.36	2,699.86	272.28
Total of 50 yr payments - 1975 to 2025				13,614.0

Preference Sets

The purpose of a preference set is to present the reader with several major considerations involved in the selection of an alternative plan. Three categories of preference sets are presented to represent three distinct levels of consideration and decision making. These classifications portray the choices of a resident and taxpayer of the Southeastern Michigan study area, a decision maker on the local or State of Michigan level, and a decision maker on the national level (Tables 38 and 39).

The three representative wastewater management plans considered in this study to meet the 1985 Water Quality Goals and the Interim Water Quality Plan developed by the State of Michigan are examined. While not intended to be exhaustive, the considerations presented are significant and would certainly come under scrutiny in the examination of these potential wastewater management proposals.

TABLE 39

PREFERENCE SETS
FOR
THE DECISION MAKER AT LOCAL AND STATE LEVEL

Interim Water Quality Plan

Selection of the Interim Water Quality Plan indicates that a decision maker on both local and State of Michigan levels prefer to:

1. Accept the interim water quality goals for 1983, as established by Public Law 92-500, as the state or regional water quality goals.

2. Retain a significant number of existing wastewater treatment plants and recognize the accompanying economic political and technological considerations associated with treatment at this level.

3. Finance, in part, a wastewater management plan which is the least expensive of all proposals.

4. Avoid the use of large amounts of agriculture land for wastewater treatment.

5. Implement a wastewater management proposal which relies less on energy and chemical resources for treatment and more on the assimilative capacity of the receiving water to reduce the effects of waterborne wastes.

6. Implement a plan which would consume a significantly less amount of chemical and energy resources than any of the otherroposed plans.

And Acknowledges That:

1. Implementation of this plan alone will not achieve the 1985 water quality goals established by Public Law 92-500.

2. The interim water quality plan would collect and treat only the combined sewer overflow portion of stormwater runoff from urban areas.

3. This plan forgoes the opportunity to employ waste treatment technologies which emphasize recycling of wastewater.

Representative Plan I

Selection of Representative Plan I indicates that a decision maker on both local and State of Michigan level prefers to:

1. Accept the water quality goal of "no discharge of critical pollutants", established by Public Law 92-500 as the state or regional water quality goal.

2. Retain a significant number of existing wastewater treatment plants and recognize the accompanying economic political and technological considerations associated with treatment at this level.

3. Finance, in part, the least expensive plan of all other wastewater management proposals which would approachthe 1985 water quality goal.

4. Avoid the use of large amounts of agriculture land for wastewater treatment.

5. Implement a system which does not rely on the assimilative capacity of the receiving water to achieve high levels of water quality.

And Acknowledges That:

1. Several existing wastewater treatment plants will be phased out of operation.

2. This plan offers the least opportunity to employ treatment technologies which emphasize recycling wastewater of the proposals which approach the 1985 water quality goal.

3. Implementation of this Plan will consume large amounts of both chemical and natural resources, and the power to generate them.

4. Implementation of this Plan will retard to small degree the degradation of Lake Erie.

Representative Plan II

Selection of Representative Plan II indicates that a decision maker on both local and State of Michigan level prefers to:

1. Accept the water quality goal of "no discharge of critical pollutants", established by Public Law 92-500 as the state or regional water quality goal.

2. Finance in part a wastewater management proposal which is the least expensive of the two plans designating land irrigation treatment of wastewater as a part of the overall treatment plan.

3. Introduce, in those areas designated for land irrigation treatment facilities, the potential to preclude forms of undesirable land use by the incorporation of controlled open space.

4. Implement a proposal which presents an opportunity for recycling of wastewater.

5. Implement a wastewater management plan which incorporates a system of land irrigation treatment and process plant treatment of wastewater; recognizing the accompanying economic, political, and technological considerations associated with this level of treatment and the high degree of control required in this land treatment system.

6. Implement a system which does not rely on the assimilative capacity of the receiving water to achieve high levels of water quality.

And Acknowledges That:

1. Several existing wastewater treatment plants will be phased out of operation.

2. The land use pattern of large amounts of agricultural land will be fixed for a long time period by implementation of this plan.

3. Implementation of this Plan will consume large amounts of both chemical and natural resources, and the power to generate them.

4. This plan is more expensive than all other proposals, with the exception of Representative Plan III.

5. Implementation of this Plan will retard to small degree the degradation of Lake Erie.

6. Implementation of the land irrigation portion of this plan would displace all residents of land irrigation areas.

7. Strict control of large amounts of agriculture land would be required to implement this plan.

Representative Plan III

Selection of Representative Plan III indicates that a decision maker on both local and State of Michigan level prefers to:

1. Accept the water quality goal of "no discharge of critical pollutants", established by Public Law 92-500 as the state or regional water quality goal.

2. Implement, in those areas designated for land treatment, a plan which would allow residents to remain on their property and have the maximum allowable control of their land as it is being used for wastewater treatment.

3. Introduce, in those areas designated for land irrigation treatment facilities, the potential to preclude forms of undesirable land use by the incorporation of controlled open space.

4. Implement a proposal which presents the best opportunity for recycling of wastewater.

5. Implement a wastewater management plan which incorporates a system of land irrigation treatment and process plant treatment of wastewater, recognizing the accompanying economic, political, and technological considerations associated with this level of treatment and a land treatment system which gives maximum allowable control to the land owner and farmer.

6. Implement a system which does not rely on the assimilative capacity of the receiving water to achieve high levels of water quality.

And Acknowledges That:

1. Several existing wastewater treatment plants will be phased out of operation.

2. The land use pattern of large amounts of agricultural land will be fixed for a long time period by implementation of this plan.

3. Implementation of this Plan will consume large amounts of both chemical and natural resources, and the power to generate them.

4. This plan is the most expensive proposal.

5. Implementation of this Plan will retard to small degree the degradation of Lake Erie.

6. Strict control of large amounts of agriculture land would be required to implement this plan.

TABLE 38

PREFERENCE SETS FOR RESIDENTS OF THE SOUTHEASTERN MICHIGAN WASTEWATER MANAGEMENT STUDY AREA

Interim Water Quality Plan	Representative Plan I	Representative Plan II	Representative Plan III
Selection of the *Interim Water Quality Plan* indicates that a resident (and taxpayer) of the southeastern Michigan wastewater management study area prefers to:	*Selection of Representative Plan I indicates that a* resident (and taxpayer) of the southeastern Michigan wastewater management study area prefers to:	*Selection of Representative Plan II indicates that a* resident (and taxpayer) of the southeastern Michigan wastewater management study area prefers to:	Selection of Representative Plan III indicates that a resident (and taxpayer) of the southeastern Michigan wastewater manamgenet study area prefers to:
1. Implement a plan which would, at best, meet the 1983 water quality standard established by Public Law 92-500.	1. Implement a plan which would approach with the best available technology the 1985 "no discharge of pollutants" goal of Public Law 92-500.	1. Implement a plan which would approach with the best available technology the 1985 "no discharge of pollutants" goal of Public Law 92-500.	1. Implement a plan which would approach with the best available technology the 1985 "no discharge of pollutants" goal of Public Law 92-500.
2. Retain a significant number of existing wastewater treatment plants and recognize the accompanying economic political and technological considerations associated with treatment at this level.	2. Retain a significant number of existing wastewater treatment plants and recognize the accompanying economic political and technological considerations associated with treatment at this level.	2. Finance in part a wastewater management proposal which is the least expensive of the two plans designating land irrigation treatment of wastewater as a part of the overall treatment plan.	2. Implement, in those areas designated for land treatment, a plan which would allow residents to remain on their property and have the maximum allowable control of their land as it is being used for wastewater treatment.
3. Finance, in part, a wastewater management plan which is the least expensive of all proposals.	3. Finance, in part, the least expensive plan of all other wastewater management proposals which would approachthe 1985 water quality goal.	3. Introduce, in those areas designated for land irrigation treatment facilities, the potential to preclude forms of undesirable land use by the incorporation of controlled open space.	3. Introduce, in those areas designated for land irrigation treatment facilities, the potential to preclude forms of undesirable land use by the incorporation of controlled open space.
4. Avoid the use of large amounts of agriculture land for wastewater treatment.	4. Avoid the use of large amounts of agriculture land for wastewater treatment.	*4. Implement a proposal which presents an* opportunity for recycling of wastewater.	*4. Implement a proposal which presents the best* opportunity for recylcing of wastewater.
5. Implement a plan which would consume a significantly less amount of chemical and energy resources than any of the otherroposed plans.		5. Implement a wastewater management plan which incorporates a system of land irrigation treatment and process plant treatment of wastewater; recognizing the accompanying economic, political, and technological considerations associated with this level of treatment and the high degree of control required in this land treatment system.	5. Implement a wastewater management plan which incorporates a system of land irrigation treatment and process plant treatment of wastewater; recognizing the accompanying economic, political, and technological considerations associated with this level of treatment and a land treatment system which gives maximum allowable control to the land owner and farmer.
And Acknowledges That:	**And Acknowledges That:**	**And Acknowledges That:**	**And Acknowledges That:**
1. Implementation of this plan alone will not achieve the 1985 water quality goals established by *Public Law 92-500*.	1. Several existing wastewater treatment plants will be phased out of operation.	1. Several existing wastewater treatment plants will be phased out of operation.	1. Several existing wastewater treatment plants will be phased out of operation.
2. The interim water quality plan would collect and treat only the combined sewer overflow portion of stormwater runoff from urban areas.	2. This plan offers the least opportunity to employ treatment technologies which emphasize recycling wastewater of the proposals which approach the 1985 water quality goal.	2. The land use pattern of large amounts of agricultural land will be fixed for a long time period by implementation of this plan.	2. The land use pattern of large amounts of agricultural land will be fixed for a long time period by implementation of this plan.
3. This plan forgoes the opportunity to employ waste treatment technologies which emphasize recycling of wastewater.	3. Implementation of this Plan will consume large amounts of both chemical and natural resources, and the power to generate them.	3. Implementation of this Plan will consume large amounts of both chemical and natural resources, and the power to generate them.	3. Implementation of this Plan will consume large amounts of both chemical and natural resources, and the power to generate them.
		4. This plan is more expensive than all other proposals, with the exception of Representative Plan III.	4. This plan is the most expensive proposal.
		5. Implementation of the land irrigation portion of this plan would displace all residents of land irrigation areas.	

Chapter 9

CONCLUSION AND RECOMMENDATIONS

A general public awareness of the need to improve water quality in Southeastern Michigan plus recent Federal and State of Michigan requirements for improved effluent discharges and water quality standards, have made it necessary to plan for the implementation of more advanced wastewater management systems throughout the area in the near future. The aim of the Southeastern Michigan Wastewater Management Survey Scope Study is to develop long range wastewater management plans for Southeastern Michigan which would complement the water quality plans of the State of Michigan and thus assist in meeting the planning requirements of the Federal Water Pollution Control Act Amendments of 1972 (Public Law 92-500).

The following premises were established during the study.

1. Growing concerns with broader environmental problems and recent Federal and State legislation have changed the focus on water quality management to include regional solutions, multiple use, and multiple objectives.
2. Southeastern Michigan will sustain its economic and population growth over the next 20 years, but at lower rates than the previous two decades.
3. The Southeastern Michigan region's availability to ample supplies of high quality water will not only sustain the growing population and economic activities, but will serve as an incentive to further growth.
4. The water quality of Southeastern Michigan has been significantly degraded by urban and industrial expansion.
5. The control of combined sewer overflows is a pressing wastewater management problem in Southeastern Michigan.
6. As municipal-industrial wastewater and combined sewer overflows are controlled, separate urban stormwater runoff will become the major source of pollution from the metropolitan area if it is not also treated.

7. The configuration of existing wastewater facilities and current planning reflects a trend toward regional centralization in Southeastern Michigan.

The following general conclusions were drawn based on the seven premises.

1. The Interim Water Quality Plan could, at best, meet the 1983 requirement of "best practicable technology" in Public Law 92-500.
2. The three Representative Plans would approach with best available technology, the "no discharge of pollutants" goal of Public Law 92-500.
3. Implementation of any one of the four final alternative plans would result in significant improvements in the water quality of the inland rivers; however, inland river water quality would be expected to be somewhat higher for the Representative Plans than for the Interim Plan.
4. Implementation of any one of the four final alternatives would improve water quality of Lake Erie; however, only the Representative Plans, as part of a basin wide program, would have any effect on retarding the accelerated rate of eutrophication in the Lake.
5. Implementation of any one of the four final alternative plans would result in water quality suitable for total body contact recreation.
6. Implementation of any one of the four final alternatives would place a significantly higher demand on the energy resources of the region.
7. The construction of any one of the four final alternative plans would place significant demands on the construction resources of the region including manpower, equipment, and building materials.
8. Storage of combined sewer overflows and urban stormwater runoff will require large amounts of land close to urban areas.
9. The capital cost of the final alternatives range from \$2.3 billion for the Interim Water Quality Plan to \$4.5 billion for Representative Plan Three.
10. Construction of any one of the final alternative plans would have to begin by January 1, 1975 to meet the schedule set forth in Public Law 92-500.

Several specific conclusions were drawn during the evaluation of technical designs. These conclusions guided the development of the final alternatives for choice presented in the study.

1. Land treatment is acceptable and feasiblie for use only in specific portions of the study area.

2. For those wastewater plans involving complete or partial use of "plant type" processes the following conclusions are drawn:

a. In most cases where an existing treatment plant site is to be retained the advanced waste treatment (AWT) technology is the most cost-effective approach;

b. Where completely new plants are required, Independent Physical-Chemical Treatment is the most cost-effective technology;

c. Because of availability of land and location of the treatment plants the most cost-effective method of sludge disposal from "plants" is incineration and land fill;

d. In the rapidly urbanizing areas the most appropriate cost-effective method of treating combined sewer overflows and urban stormwater runoff is through short term storage and treatment, on an intermittent flow basis, in IPCT plants.

It is recommended that:

1. The report be made available to all Federal agencies, the State of Michigan, regional clearinghouses and local government agencies having an interest in the control and development of water and related land resources, including wastewater management systems in the area affected by the study;

2. The report be used by those agencies responsible for planning wastewater management systems to help meet the requirements of section 201 (g) (2) (A) of PL 92-500;

3. The report be forwarded to Congress for its information; and

4. After responsible state and local agencies select a plan, demonstration programs of the selected technologies be made, using specific wastes, to establish and refine criteria for detailed design of facilities.

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